The Value of Preserving Nature

Preference Uncertainty and Distributional Effects

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Abstract

This thesis deals with valuation of nonmarket goods using contingent valuation and consists of four papers and an introduction to the research area.

Paper [I] examines the public benefits from preserving old-growth forest in the sub-mountainous region in Sweden. Specifically, it analyzes a preservation program suggested by the Swedish Environmental Protection Agency. The results show that people value preservation for different reasons, not necessarily related to physical use. The paper finds that the estimated public benefits of the program exceed the estimated opportunity cost of forgone timber revenues and it should therefore be implemented. The paper also finds that there is no regional imbalance in the distribution of the benefits.

Paper [II] examines the public benefits from preserving the four large predators in the Swedish fauna. Specifically, the paper focuses on the differences in attitudes and willingness to pay between people in wolf areas and other regions. We find that a clear majority of people in wolf areas are against preserving predators and that many of them need to be economically compensated in order to accept implementation of the predator policy package. The public in Sweden is, by a narrow margin, against implementation. The overall mean WTP is approximately SEK 300. It cannot be ruled out that the public benefits may be outweighed by the public costs following implementation.

Paper [III] presents a new approach for treating preference uncertainty in contingent valuation. Specifically, it studies how data elicited from a multiple bounded question should be modelled. The new approach is compared to one of the conventional approaches and we find that: (1) it is more intuitive; (2) it better fits the data; (3) it gives more precise estimates of mean and median WTP; (4) it is less sensitive to distributional assumptions; and (5) it is better suited for policy analysis.

Paper [IV] examines the income-effect in contingent valuation. Specifically three issues are analyzed: (1) the choice of income measure; (2) the choice of modelling assumptions; and (3) the social context. The results show that the estimated income-elasticity of WTP is fairly sensitive to different choices. The most statistically precise estimate is produced using household income and controlling for household characteristics. The third issue (social context) is approached by studying the answers to a WTP question conditioning respondents on a change in (1) their personal income and (2) the average income in Sweden. The results suggest that not only the income level per se influences WTP, but also its relation to the income of others.

Keywords: contingent valuation, nonuse values, preference uncertainty, income-effect.

Acknowledgement

Let me start by defining the model. Assume that I get my Ph.D. degree and that I survive the seminar the 6th of December 2007. Under these circumstances, it is possible to derive some very pleasant results. First, it is evident that *the things that do not kill you, makes you stronger*. Second, neither necessary nor sufficient conditions are satisfied to reject the saying that *you suffer and then you die*. A strong notion, though, is that it is incorrect. Instead it should say; *you suffer, become a Ph.D.-student, suffer even more, get your Ph.D. degree, get happy (or suffer more), and then you die*. Today, I am very happy and we will see how it continues!

Many of you who read this have "walked the line" before me and you know what it is all about; blood, sweat and tears. Probably you have rewritten the history and say "it was the best days of my life", or "I never had so much spear time", or even "it was so easy to relax after work, just thinking about nothing". Brothers and Sisters! I talk about the hard way, the rollercoaster and schizophrenia of a Ph.D.-student. Sometimes everything is great and sometimes everything is just shit (there is no better word). The papers do not write themselves, one suffers for each little symbol added, and then when it all comes around few people find them interesting or even well written. Today, after five years, five hundred new CD records (at least), millions of dead brain cells, seven kilos heavier, and as poor and confused as ever, it is over. This will be the day to remember for the rest of my life. Amen![1]

Some people have helped me a great deal during my time at the Department of Economics in Umeå. I first would like to thank my supervisor Runar Brännlund for giving me the opportunity to develop as an economist in my own way and for all the snuff (snus) he attached to my hand-ins. Runar is one of the most intuitive and enthusiastic economists I know of and it has been a privilege to be his student. I hope that we will do research together in the future. I also would like to thank Karl-Gustaf Löfgren (Kalle), my vice-supervisor and trot-mate, who has lots of experience and shared it generously through his excellent story-telling. Kalle has always taken the time to read my papers and comment on them sufficiently to keep my brain activity running and he also arranged so that I could study one semester at the University of California, Berkeley. During that semester I was well taken care of by my friend Peter Berck, who should have lots of thanks for that. Peter is truly a wise man with a good sense of humour.

[1] If you are not from Norrland in Sweden, do not misunderstand my feelings. Truly, I am very satisfied with how things turned out for me.

The persons most important to me during the last five years have been (David) Granlund, (Thomas) Jonsson, Linda (Thunström) and Mikael Witterblad (also known as Markström). You made my days better in so many ways and I love you for that. I hope that we stay in touch years here after.

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Umeå, October 31, 2007

Thomas Broberg

List of Content

1. Introduction

The four papers presented in this thesis relate to the economic valuation of nonmarket goods using the contingent valuation method. Paper [I] and Paper [II] estimate the public benefits derived from implementation of two Swedish preservation policies, one concerning old-growth forests and the other predators. The contributions of these papers to the existing literature are strictly empirical. Paper [III] and Paper [IV] deal with two methodological issues specific to the contingent valuation method: preference uncertainty and the income-effect.

Below I will provide an introduction to the increasingly salient field of economic valuation of environmental goods. First, I argue that the need for using nonmarket valuation is an essential part of informing prudent and defensible policy making. Next I further develop the theoretical basis for one of the most predominant methods for valuing nonmarket environmental goods: contingent valuation (CV). Finally, I conclude with a short history of CV, with a special focus on the specific methodological issues discussed in this thesis.

2. The need for nonmarket valuation and contingent valuation

In economic theory, the concept of value reflects the utility humans derive from goods and services. It is easy to see that most things in this world have a value, positive or negative. Whenever there is a choice, a valuation has to be made. Choices reflect individuals' preferences and concern, issues such as: how much time to spend on different activities; what commodities to buy; what hairdresser to employ; and how much money to save for future consumption. Preferences, choices and values cover more than the goods and services traded in markets. Many things that we enjoy are for free and not subject to any market transaction, still we value them, e.g. the value of picking berry, watching birds, breathing clean air and swimming in the ocean. Krutilla (1967) argued that people may even derive utility (value) from "things" just because they exist, i.e. "things" may be valuable without being physically used. For example, utility may originate from the pure knowledge that there exists a virgin nature somewhere. Krutilla labeled such values "existence values".

The concept of economical value, described above, implies that it is important to consider the citizens preferences, and values, when decisions are to be made in a social welfare context. Two particularly relevant examples for this thesis include: (1) when deciding whether to clear-cut a public forest, not only the timber benefits should be considered but also the opportunity cost in terms of foregone use and nonuse values following timber harvesting; and (2) when designing

hunting laws concerning predators not only the predation costs should be considered but also the existence values that people hold for these animals.

To make values comparable, they have to be expressed in terms of a similar unit of measurement, typically money. For example, it would be hard to know whether people prefer forest conservation or timber harvest without being able to measure their preferences for these two outcomes with a common measuring stick. The most familiar and recognizable measuring stick for this purpose is, money. Given the social importance of this money metric, it would be extremely useful to apply a method that can measure preferences in terms of money. This is where contingent valuation (CV) enters. Below I provide a brief overview of welfare theory under imposed quantity constraints (Johansson, 1987) in order to understand the application of CV in this thesis.

Welfare theory starts with the assumption that people derive utility ("happiness") from the consumption of both private and public goods. To simplify, assume that there is only one public good that (1) is not traded in the market, and (2) can be consumed free of charge. Assume further that people are capable by themselves of making the best choices available to them (i.e. maximize their utility with respect to their budget constraints). To be relevant to a typical resource problem, we also assume that individuals cannot adjust the quantity (or quality) of the public good available to them (i.e. there is a fixed amount of clear air, clear water, health forest, etc.) and therefore they must make consumption choices conditioned on a given supply.

Under these assumptions the relevant welfare measures of a changed supply (or quality) of a public good are *compensating surplus* (CS) and *equivalent surplus* (ES). If the valuation scenario is perceived as an improvement by an individual, CS and ES correspond to her *willingness to pay* (WTP) and *willingness to accept* (WTA), respectively. The relevance of money enters the equation here because it can be used indirectly to help assess an individual's trade-off between her consumption of a public good (Z) and private goods. Since money (Y) can be used to purchase private goods, it is equivalent to an amount of private goods. This trade-off between a public good and money are illustrated in Figure 1.

If the quantity of Z increases, the individual will experience a higher utility (U) and would therefore be willing to pay for such a change (i.e. give up money in order to obtain the increase in Z). The individual could pay as much as CS for the increase without being worse off compared to the initial situation, i.e. the individual's maximum WTP for the quantity increase equals CS. The ES measure equals the minimum compensation needed to make the individual willing to forgo the increase. The two welfare measures differ with respect to the baseline (i.e. starting) level of utility

used to derive them; CS is based on the pre-environmental change utility level and ES on the post-environmental change utility level.

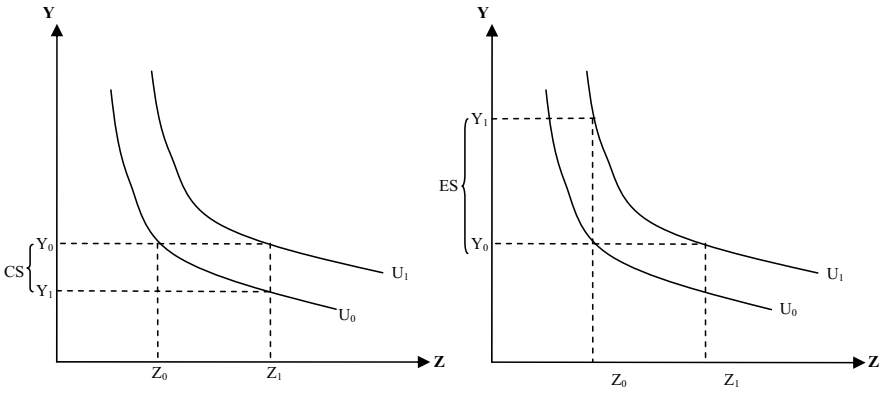

Figure 1: Welfare measures under imposed quantity constraints of a public good which can be consumed free of charge.

In principle, it is possible to derive a monetary measure of the welfare effect that follows from a changed supply of the public good by directly asking the individuals to state their maximum WTP or minimum WTA (i.e. to state their personal trade-off between money and the proposed environmental change). Ciriacy-Wantrup (1947) suggested such an approach to gather information about the demand for non-excludable benefits from preventing soil-erosion (such as reduced siltation of streams). However, the author did not put the theory into practice. Instead Davis (1963), became the first CV publication by estimating the value of a specific recreational area in the U.S. Today hundreds of CV studies, concerning all kinds of goods and services, have been conducted (an overview of the literature can be found in Carson et al., 1994; Carson, forthcoming).

Since the initial application of the CV method over 40 years ago, its use has been heavily scrutinized by critics. As a direct result of the scrutiny provided by the publication and peer review process, the CV method has evolved (perhaps to the dismay of some adamant critics). The evolution has led to a number of refinements (some dare say *improvements*) which are too numerous to discuss here. However, two issues are relevant enough to deserve further discussion in this thesis: (1) the WTP question itself (e.g., the format for eliciting WTP in the survey) and (2) the statistical measure (mean/median) to estimate the distribution of the key random variable: an individuals WTP for an environmental change.

The state-of-art has evolved from an open-ended format (leaving it open to individuals to state their maximum WTP) to closed-ended formats (where researchers provide different levels of bid(s) which respondents accept or reject). In this move toward closed-ended formats the dichotomous choice (DC) structure has become increasingly popular. The DC format includes only a single bid and assumes that the individual will accept the bid if her WTP is higher than or equal to that bid amount. The amount or amounts used in closed-ended formats are varied over individuals which makes it possible to apply various statistical techniques to reveal information about the distribution of WTP among the population. A third approach, which is a mix of the open-ended and closed-ended formats, is to present a payment card listing several amounts and ask people to circle the highest amount they would agree to pay (or as an alternative the amount that is closest to their maximum WTP). To the authors knowledge the earliest applications of the two latter formats are found in Bishop and Heberlein (1979) and Mitchell and Carson (1981), respectively. Important contributions to the DC and the payment card format are provided in Hanemann (1984), Cameron and James (1986), Cameron (1988), Cameron and Huppert (1989) and Kriström (1997).

The DC format has two appealing attributes to researchers, both of which are frequently mentioned in the CV literature. First, the format mimics the "take it or leave it" offer typically found in a market scenario (i.e. it is familiar to people). Second, it reduces an individual's incentive to influence the final outcome by falsely reporting a WTP that is higher or lower than she would actually pay. This is often referred to as the "incentive-compatibility" problem inherent in the CV method (Arrow et al. 1993). The major drawback with the DC format is that the researcher receives relatively little information about a respondent's WTP. That is, the DC survey data can only tell the researcher if a respondent's WTP is higher or lower than the amount presented to her (in contrast, the open-ended format provides an unequivocal data point). A relatively large number of respondents are therefore needed to estimate the WTP distribution with sufficient precision. As a result, the DC format can be more expensive compared to other elicitation formats.

A second theme in the evolution of the CV method is the statistical measure used to describe the WTP distribution (i.e. the estimated random variable in the CV model). When applying the open-ended format, the aggregated arithmetic mean can be used as the welfare measure, which is not possible when using closed-ended formats. The typical procedure for analyzing such data first derives, non-parametrically or parametrically, the survival function, which gives the probability of accepting a specific bid. The average WTP is then calculated by integrating the area under the survival curve (see Figure 2). Parametric approaches typically follow Cameron (1988) and initially assume the distributional pattern of the WTP, e.g. assume that WTP follows a logistic

probability distribution. Statistical techniques are then applied on the data to determine the location and shape of the specific distribution. Several studies have shown that the average WTP is sensitive to the initial distributional assumption (e.g. Kriström, 1990; Johansson, 1993; Hanemann and Kanninen, 1999). The problem arises because there is too little information about the tails of the distribution, and can in extreme cases lead to an infinite mean (Bishop and Heberlein, 1979). To solve the problem, some researcher suggest truncating the data (e.g. cutting extremely high or low values), but such approaches are criticized for being arbitrary since the researcher herself cannot objectively decide the WTP levels at which to truncate the distribution (Johansson, 1993; Hanemann, 1984). Instead, the median WTP, which has been found to be less sensitive to the distributional assumption of WTP, is the preferred measure of central tendency in many studies.

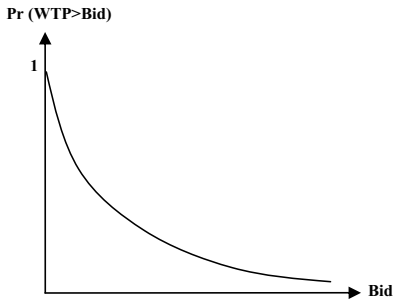

Figure 2: Survival curve for WTP. The mean WTP is calculated by integrating the area under the curve.

Some economists base their support for the median measure of WTP on considerations of fairness related to public projects. Contingent valuation studies are typically conducted to assess benefits and costs attached to a specific good or project. The standard criteria that economists apply to judge whether solutions, or decisions, are socially wanted or efficient, is the Pareto-criteria. According to the Pareto-criteria a public project should not be implemented if it will bring negative consequences for any individual or firm in the society. Public projects typically imply both winners and losers and therefore the Pareto-criteria are of little use in policy analysis (i.e. an otherwise beneficial project should be prevented if it produces a single loser). An alternative is the Kaldor-Hicks potential compensation criteria which suggest that a project is socially beneficial if the winners can theoretically compensate the losers. However, some critics point out that the Kaldor-Hicks potential compensation criteria is not democratic. This is because policy measures based on mean WTP estimates tend to favor those at the extreme ends of the spectrum (i.e., those that are willing to pay a lot or nothing). In contrast, policy decisions that are based on a median measure of WTP tend to have more attractive distributional impacts on society because such

decisions place less weight in the "extreme" WTP estimates (the median is said to be democratic because the majority of the population would agree to pay that amount). Rigorous discussions of the mean versus median issue can be found in Johansson (1993) and Hanemann and Kanninen (1999).

3. Nonmarket values and contingent valuation

People may hold values for goods and services (including natural resources) for many reasons. Commonly, we refer to four different value categories: (1) *use value*, people derive utility from the direct use of goods or services; (2) *existence value*, people may derive utility based on the mere existence of a good or a service (Krutilla, 1967); (3) *option value*, people may value the option to use resources in the future (Weisbrod, 1964), or the option to procrastinate decisions into the future when more information is available (Fisher and Krutilla, 1985); and (4) *altruism/ bequest value*, people may value the availability of goods and services for other people or future generations. The first of these four values is distinct from the other three in that it involves physical use of a good. To distinct it from the other values described above, we refer to, existence, option, bequest/altruism values, as nonuse or passive-use values.

The CV method has appeal because its hypothetical nature makes it possible to estimate values that are seemingly unrelated to human behavior, which is a prerequisite for the travel cost and the hedonic approaches to nonmarket valuation (Carson et al., 2001; Portney, 1994; Hanemann, 1994). Nunes and van den Bergh (2001) surveyed the literature on the valuation of biodiversity and concluded that the contingent valuation approach is the preferred valuation method for valuing goods and services related to biodiversity; "*since it is the only one that can assess the magnitude of nonuse values, such as the existence value of the knowledge that the natural habitats, and its wildlife diversity, is kept free from commercial development and closed to visitors*". This conclusion is theoretically strong, though it is perhaps a bit misleading by referring to the CV method as the only one capable of estimating nonuse values. In fact, other methods that rely on hypothetical markets, such as choice-experiments, could also be used to assess nonuse values (Christie et al., 2006).

The CV method received great attention in the aftermath of the Exxon Valdes oil spill off Alaska's coastline in 1989. This large damage incident in a sensitive ecosystem provided economists with a unique opportunity to apply the CV method to estimate how the public valued this environmental change. The CV assessment, estimated a loss in "existence value" to the American Public to be as large as US $ 3 billion (Carson et al., 1992 and 2003). This enormous sum of money attracted criticism from those who did not believe CV was a sound method to elicit

such values (though most economic critics did not disagree with the assertion that such nonuse values exist). To the extent that this exercise captured how Americans value a resource that they may never use, the result indicates the importance of considering all relevant benefits and costs attached to public environmental projects (e.g. incident). The strong message to policy makers was that nonmarket values may be as large as or even larger than the traditionally-accepted use of market values in considering the social benefits attached to public projects.

Paper [I] and Paper [II] found in this thesis applies the CV method to estimate public benefits derived from preservation of old-growth forests and the four large predators in the Swedish fauna, respectively. Both of these represent public projects for which citizens likely hold nonuse values. These papers also address the spatial distribution of the benefits (e.g. where the winners and losers are found in the population).

4. Summary of Paper [I]: Assessing the non-timber value of old-growth forests in Sweden

In 2002 the *Swedish Environmental Protection Agency* was commissioned by the government to assess the environmental value of the State's forests, with a focus on old-growth forests. The State owns almost all of the old-growth forests in Sweden, which are mainly concentrated in the sparsely populated sub-mountainous area in Northwestern Sweden. A large part, 43% or 660,000 hectares, of the old-growth forests in this area were protected in 2002. The results from the forest assessment were published in 2004 and concluded that there were an additional 126,000 hectares (8 percent) of productive old-growth forest in the sub-mountainous region worthy of additional preservation. However, this conclusion was based only on biological assessment without any consideration of the economic costs or benefits. The objective of this paper is to estimate the public willingness to pay for implementing the suggested preservation program using the method of contingent valuation.

The primary reason of this *in-situ* (i.e. "in-place") conservation of biodiversity is the forest's relative diversity and richness, which provides important habitat for threatened species. Thus, benefits arise predominantly from nonuse values. The results show that a majority of the Swedish population is unwilling to contribute financially to the preservation program (median WTP equals zero). The estimated annual mean WTP, conditioned on a five year payment commitment, is SEK 300. This implies an aggregate benefit of approximately SEK 9 billion. An upper bound for the preservation program's opportunity cost is estimated to be approximately SEK 3.5 billion, which suggests that the preservation program is socially beneficial and should be implemented. The conclusion is based on the Kaldor-Hicks criteria, which says that a project is socially beneficial if

it is possible for the "winners" to fully compensate the "losers". This criteria, do not consider distributional effects on the affected population. Therefore it is particularly relevant to explicitly study value determinants, i.e. the characteristics of an individual that leads her to support or reject the proposal. The distribution of benefits is of particular interest to this study because the old-growth forests are concentrated in one geographical area which potentially may cause a spatial imbalance relevant to the dispersed Swedish population.

The paper estimates two different valuation functions to study determinants of the WTP. First, a binary logit model indicates that variables related to a respondent's education level, income level, and concern about the environment are *positively* correlated with the likelihood of supporting the preservation program, while being a male and wanting the public expenditures on the environment to decrease are *negatively* correlated. After controlling for whether locals are employed in forest-related industries, it is found that locals, in general, are more likely than non-locals to have a positive WTP. Second, the paper estimates a valuation function conditioned on respondents with a positive WTP and the results show that the sizes of respondents' contributions are explained by income, general concern about the environment, and the motive underlying their valuation. Respondents that stated that they only valued the proposed program for its nonuse attributes reported rather large values but still lower than those who based their valuation on use attributes as well. No significant difference concerning the size of WTP is found between locals and non-locals. The results suggest that the benefits from the proposed preservation program are evenly distributed among the Swedish population.

5. Summary of Paper [II]: On the value of large predators in Sweden: A regional stratified contingent valuation analysis.

The governmental predator policy, which was decided in 2001, aims at securing the survival of the four large predators in the Swedish fauna: (1) wolves (*Canis lupus*); (2) bears (*Ursus arctos*); (3) lynx (*Lynx lynx*); and (4) wolverines (*Gulo gulo*). Successful implementation of the Swedish government's predator policy means that the number of wolves and wolverines will increase significantly in the Swedish fauna while the populations of bears and lynx will remain at their current levels. The attitudes toward the predator policy are to a large extent driven by the attitudes toward the wolf population since the wolverine is unfamiliar to many people.

Historically, the wolf population has been spread all over the Swedish mainland, but is today concentrated in the mid-west of Sweden. After many years of human persecution the wolf population was almost exterminated from the Swedish fauna. By the late 1960's the wolf population consisted of approximately ten adult animals. Today it totals about 120 animals. The

wolf population is still classified as endangered and, according to biologists, requires protection from illegal hunting to maintain a sustainable population. Implementation of the predator policy means that the number of wolves in the Swedish fauna will grow to about 200 animals in a first stage.

In 2004 a survey study were conducted to investigate the attitudes toward the predator policy and to ultimately estimate the welfare effect that would follow from its implementation. The results from the survey study show that fifty percent of the Swedish population is willing to contribute financially to implement the predator policy. The estimated overall mean WTP is approximately SEK 300. Further, we test for spatial differences in attitudes and WTP and find that respondents in Stockholm have the highest overall mean WTP, while respondents living in wolf-territories have the lowest. A clear majority in the wolf areas do not support the predator policy. Our overall estimated mean WTP measure is flawed with upward bias, since we cannot estimate the willingness to accept for those with clearly negative preferences regarding the predator policy package. In this paper, we set their WTP equal to zero. However, it is possible and even plausible that these respondents would actually have a negative WTP (i.e. they would require compensation, rather than pay to support, the predator policy). Finally, the estimates of the overall WTP are sensitive to response-uncertainty. When the respondents indicate uncertainty about their valuation, they tend to state higher values. An absolute upper bound of the overall mean WTP is approximately SEK 800.

6. Preference uncertainty and the income-effect in contingent valuation

The legal process following the Exxon Valdez catastrophe resulted in a fundamental evaluation of CV, its ability to estimate existence values and its use in damage assessment in the U.S. In 1993 an important reference in the CV literature was published, the report of the National Oceanic and Atmospheric Administration panel (the NOAA-panel).[1] The panel of expert economists concluded that CV could be used in legal damage assessment to estimate existence values, assuming that certain characteristics of the valuation study were consistent with the state-of-the-art. For example, the panel concluded that data collection should be based on personal interviews with respondents rather than on phone- or mail surveys. Other conditions that CV surveys should meet to ensure their conclusions are credible and defensible include the following: preference for WTP rather than WTA; the use DC format phrased as a referendum; a reminder for respondents to consider budget constraints and substitutes; a precise description of the valuation scenario; inclusion of a "no response" option; inclusion of control variables; and follow-up questions to test the consistency of WTP responses.

[1] Arrow et al. (1993)

Today, the CV method has become one of the predominant nonmarket valuation methods, presumably due to its ability to capture nonuse values. In spite of its popularity, it has been criticized by critics who suggest that the estimated values are flawed due to hypothetical and strategic bias (Kahneman and Knetsch, 1992; Diamond and Hausman, 1994; Harrison, 2006). Several studies have found that the DC format overestimates the actual WTP, and that individuals are more likely to accept hypothetical offers from a survey rather than actual offers in a market transaction (Cummings et al., 1995; 1997). A number of studies have further shown that individuals uncertain about their WTP tend to say "yes" when answering a DC question (Champ et al, 1997; Welsh and Poe, 1998; Champ and Bishop, 2001; Vossler et al., 2003). According to these results, the WTP estimates based on CV may not reflect the true value of the studied good and may need to be adjusted.

During the last fifteen years several studies have examined preference uncertainty and different calibration techniques have been suggested. Within the DC format two main approaches have been suggested. The first asks respondents to state how certain they are about their answer to the WTP question (Li and Mattsson, 1995; Champ et al, 1997; Loomis and Ekstrand, 1998; van Kooten et al., 2001). The second approach, introduce uncertainty directly into the WTP question by including uncertainty options such as "probably yes", "unsure" and "probably no" (Ready et al, 1995; Wang, 1997). Extensions of the payment card, multiple bounded and open-ended formats have also been suggested (Welsh and Poe, 1998; Cameron et al., 2002; Evans, et al., 2003; Alberini et al., 2003; and Håkansson, 2007). No consensus has emerged on how to treat preference uncertainty, neither theoretically nor empirically. This is clearly a research area that needs further attention in the future.

This thesis takes a closer look at one of the criticized aspects of the CV method: the fact that respondents may be uncertain about their true value for an environmental good. Understandably, respondents are expected to be familiar with typical market transactions such as how much they would be willing to pay for a loaf of bread or a new apartment. However, it should not be surprising that respondents may be less certain about the value they hold for things they do not usually purchase such as a preserved old-growth forest or biodiversity conservation. The key question addressed in this thesis is how researchers can take into account this natural level of preference uncertainty in interpreting CV results. Paper [III] in this thesis discusses how preference uncertainty should be incorporated into the multiple bounded and payment card formats.

A first justification test of CV estimates is to check their consistency with economic theory and *a priori* expectations. The goods and services valued in CV studies are often related to

environmental quality and a strong notion within the literature has been that such goods are "luxury goods", meaning that the demand for them should increase more than proportional to income. However, the income-elasticities found in the CV literature are typically below unity, meaning that the increase in WTP is less than proportional to the increase in income (Kriström and Riera, 1996; Hökby and Söderqvist, 2003). In addition, insignificant income-effects are not unusual (Schläpfer, 2006). These results have been used to undermine the reliability of CV estimates (McFadden and Leonard, 1993; Diamond and Hausman, 1993).

However, Flores and Carson (1997) showed theoretically that there is a fundamental difference between the income-elasticity of demand and that of WTP. The income-elasticity of WTP, estimated by CV, is conditioned on a given quantity change.[2] Information about one of the elasticities alone (e.g. WTP) is not enough to draw conclusions about the other one (e.g. demand). Thus, an income-elasticity of WTP below unity does not disqualify the corresponding good from being a luxury. Although the income-elasticity of WTP is not sufficient to classify goods as being basic or luxury goods, it says something about the distribution of benefits and, therefore, is important to study in policy analysis.

Paper [IV] in this thesis concerns estimation of the income-effect on WTP, particularly its sensitivity to the underlying choices of income measure, modelling assumptions, and the social context read into the valuation scenario.

7. Summary of Paper [III]: A new approach for analyzing multiple bounded WTP data- Certainty dependent payment card intervals

During the last fifteen years several articles have addressed the issue of preference uncertainty. The purpose of these efforts were to develop approaches that capture the inevitable uncertainty that respondents face when asked to value a good or service which is unfamiliar to them. In this paper, we analyze methodological issues concerning one of those approaches, the multiple bounded (MB) format introduced by Welsh and Poe (1998). We present a new approach for analyzing MB data, which is not only more intuitive compared to the conventional approaches, but also more precise in its estimate of mean and median WTP.

A MB question is a combination of an ordinary payment card and a polychotomous choice question introduced by Ready et al. (1995). In the MB format respondents face multiple bids

[2] The CV question aims at measuring the welfare effect of a given change in the quantity of the good being valued. Since the quantity change is given in the constructed market scenario individuals cannot freely maximize their utility with respect to quantity. For that reason, the demand function cannot be derived trough CV.

rather than one bid, as in a polychotomous choice question. The respondents are asked how likely an actual "yes-vote" would be by marking one of several verbal probability statements associated with each amount presented to them (e.g. "definitely yes", "probably yes", "unsure" "probably no" or "definitely no"). Our suggested approach for treating such data is based on the intuitive assumption that individuals, uncertain about their WTP, want to state intervals rather than precise values. The higher the degree of uncertainty, the wider the respondent's stated interval. Following this assumption, we allow the respondents to expand their WTP intervals by shifting their upper bounds as the degree of uncertainty increases. This differs from the seminal Welsh and Poe (1998) approach which condition each respondent's WTP interval on a specific probability statement. This implies that the entire WTP interval shifts upwards and, therefore, overestimates mean and median WTP in the presence of uncertainty.

To compare empirically our expansion approach to the Welsh and Poe approach, we use survey data from 2004 that elicited WTP for implementation of the predator protection policy in Sweden. Our analysis shows that the suggested approach: (1) is more intuitive; (2) better fits the data; (3) gives more precise estimates of mean and median; (4) is less sensitive to distributional assumption; and (5) is better suited for policy analysis.

8. Summary of Paper [IV]: Examining the income-effect in contingent valuation- The importance of making the right choices

CV studies typically include income as a control variable in the WTP function to validate the estimates and/or to study distributional effects. The occurrence and size of a significant income-effect is presumably a function of the studied good, the characteristics of the sample, factors controlled for, the income measure used, and the functional form applied. However, there is no consensus in the previous literature on how to model the relationship between WTP and income, implying that estimation of the income-effect is seemingly ad-hoc.

This paper contributes to the previous literature on the empirical relationship between WTP and income by identifying and studying three important issues: 1) the choice of income measure; 2) the modelling choice; and 3) the social context. The first two issues are important because different choices may lead to different estimates of the income-effect. This paper performs a sensitivity-analysis of the income-effect with respect to different income measures and modelling assumptions to shed light on the importance of making the "right" choices. The study relies on WTP data from 2004 concerning preservation of predators in the Swedish fauna. The third issue is important to study because the social context has typically been assumed away from the valuation scenario in previous CV studies, i.e. income per se, independent of other individuals'

incomes and consumption patterns, has been judged as the relevant variable to study. The social context manifested in the *relative income* may play an important part since it may influence individuals' perceptions about payment responsibilities, "fair-payments" and their propensity to free-ride on other tax-payers. If this is the case, the income-effect will be determined not only by the income level per se, but also on how it compares to the incomes of others. To study the importance of relative income, the study uses WTP data concerning preservation of old-growth forests in Sweden. More specifically, the study analyzes the answers to an experimental WTP question conditioning respondents on a hypothetical income change.

The results from the analysis show that estimates of the income-elasticity of WTP are fairly sensitive to the choices of income measure and functional form. Overall the estimated income-elasticity varies within the range of 0.07-0.49. Higher estimates are generally associated with a larger standard deviation and the differences between the estimates are almost exclusively insignificant. The highest point-estimate, which is also the most statistically precise, is produced assuming that the income-elasticity of WTP is a non-linear function of household income. The choice of using individual gross or net income shows no significant difference in the size of the income-elasticity. Using household income per household member yields a lower estimate and worse data fit compared to the model where control variables are used. The results show that controlling for household characteristics is important when using the household income variable.

When analyzing the decisions of individuals, the household income should be adjusted for the number of adults in the household before it can be compared to the income of single households. If household characteristics are not controlled for, the household income will reveal little about the income disposable to a specific household member. The conclusion is to some degree contrary to the conjecture in Kriström and Riera (1996), that inclusion of covariates in the WTP function does not change the estimated income-elasticity in any fundamental way.

A split-sample approach, using survey data concerning preservation of old-growth forests in Sweden, is applied to study the importance of relative income. An experimental CV question asked respondents how they would change their WTP (stated earlier in the survey) if their absolute income and the average income in Sweden were about to increase with a specific amount. Two samples are compared, both conditioned on the same increase in their personal income, but on different information about the change in average income. The results from this analysis indicate that respondents react on the social context given in the valuation scenario. Respondents who received a decrease in their relative income stated a significantly lower increase in WTP (on average) compared to those whose relative income remained unchanged, all other things equal. Males seem to react stronger to the change in relative income compared to females.

The results may be flawed due to the hypothetical setting used as the foundation of the analysis. Judging from the item non-response, the second valuation question proved to be troublesome. Some respondents seem to have deliberately skipped the question after answering the first valuation question. The amount of text associated with the survey and the hypothetical setting might have discouraged some of these respondents. However, even if the results may be flawed they still indicate that the social context matter to respondents.

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I

Assessing the non-timber value of old-growth forests in Sweden

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Abstract

This paper uses contingent valuation to estimate the public benefit derived from preserving 126 000 hectares of state-owned old-growth forest in the sub-mountainous region of Sweden. People value the preservation program both for its use and nonuse attributes. Nonuse values seem to be large and should not be ignored in policy analysis. The estimated annual mean WTP, conditioned on a five year payment commitment, is approximately SEK 300 and the aggregate benefit amounts to SEK 9 billion, which is almost three times higher than the program's estimated opportunity cost. The results also show that a majority of the Swedish population is unwilling to contribute financially to the preservation program (median WTP equals zero). No significant differences are found between locals and non locals concerning their preferences for contributing to the preservation program, i.e. the results do not support the hypothesis of regional imbalance in the distribution of benefits. The overall conclusion is that the program is socially beneficial and should be implemented.

Keywords: *contingent valuation; willingness to pay; public benefit; nonuse values; non-timber value; old-growth forest; preservation; conservation.*

JEL-Codes: Q20; Q23; Q26; Q28; Q38

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1. Introduction

In economic theory, the concept of value reflects the utility humans derive from goods and services. A forest's value is often used as a synonym for forest estate value or timber value, not recognizing values from all forest goods and services, e.g. the values derived from picking berry or recreation. This paper examines a Swedish forest preservation program concerning old-growth forests and uses contingent valuation to value the non-timber benefits attached to the program. Old-growth forests are unique because they represent virgin nature. As such, the expectation is that people will value them for both their use and nonuse attributes. There are several reasons to why people who do not actively use the forests may hold a value for them, such as: (1) *existence value*, people may derive utility based on the mere existence of a good or a service, e.g. an undeveloped forest (Krutilla, 1967); (2) *option value*, people may value the option to use resources in the future (Weisbrod, 1964), or the option to procrastinate decisions into the future when more information is available (Fisher and Krutilla, 1985); and (3) *altruism/ bequest value*, people may value the availability of goods and services for other people or future generations. Use value is distinct from these other three value categories in that it involves physical use of a good. To distinct it from the other values described above, we refer to, existence, option, bequest/altruism values, as nonuse or passive-use values.

Given the objective to preserve forests, policy makers face the delicate problem of deciding what areas to preserve. As described in the UN's *Convention on Biodiversity,* policies aimed at conserving or enhancing biodiversity should be designed from a landscape perspective that considers social and economic aspects. Regardless of whether biodiversity is conserved through establishment of national parks or through altered management practices, conservation implies direct impacts in terms of foregone timber profits and/or indirect impacts to local communities (e.g., increased unemployment). Brown and Shogren (1998) describe the inherent conflict between socio-economic factors and biological concerns as an urgent resource allocation problem demanding further investigation. If the cost of a specific conservation project is higher than the benefits it provides to the public, the project is not socially beneficial and needs to be refined or abandoned. A prerequisite for this type of cost-benefit analysis (CBA) is that policy makers have information about the monetary value of benefits and costs attached to the proposed project.

In 2002 the *Swedish Environmental Protection Agency* was commissioned by the Swedish government to assess the environmental value of the state's forests (state-owned), with a focus on old-growth forests. These forests represent virgin nature and are typically more diverse than commercial forests because they are formed by natural forces (e.g., fire) rather than through systematic regeneration. The relative richness of coarse woody debris (CWD) - an important substrate for many threatened species in boreal forests - makes them especially important for

biodiversity (Berg et al., 1994). Snags and logs provide critical habitat for many species (e.g., woodpeckers feeding on insects dwelling in decomposing wood). The results from the inventory were published in 2004 and concluded that there were, in addition to already protected areas in 2002, 126 000 hectares (8 percent) of productive old-growth forest in the sub-mountainous region worthy of additional preservation.[1]

In total the inventory suggested that 340 000 hectares of the state-owned forests should be preserved (including the 126 000 hectares of old-growth forests), a conclusion based on biological assessment without any consideration of the economic costs or benefits. In a report to the Swedish government (*The Swedish Ministry of Enterprise, Energy and Communication*, 2004) an approximation of the opportunity cost of the larger preservation program was estimated to SEK 9 billion. The estimate was derived by considering characteristics of the forests, (e.g. their altitude, distance to roads and volume timber per hectare) and on the assumption that all economically interesting areas would be clear-cut within a year.

This paper estimates the monetary value of the public benefits derived from establishment of new, or extensions of existing, national parks in Sweden. More specifically, three issues are focused: 1) the total value of implementing the preservation program concerning the 126 000 hectares of productive old-growth forest in the sub-mountainous area in Northwest Sweden; 2) spatial value differences; 3) motives underlying the individuals' valuations. The second issue is important because people residing relatively close to the forests ("locals") are assumed to use them more than "non-locals" and, therefore, are more likely to realize the welfare benefits arising from use services. On the other hand forest preservation may disturb the local economy and possibly cause unemployment and other indirect costs to the local community. The spatial distribution of the non-timber benefits is undetermined *a priori*. The third issue is interesting to study because the nonuse value associated with the preservation program is expected to be significant due to old-growth forests unique characteristics that will be lost if commercial harvesting is adopted. This notion is analyzed by estimating the WTP among people who do not plan to visit the study area and, therefore, only value the preservation program for its nonuse attributes.[2]

The Study's focus is on estimating the public benefits from the preservation program, which constitutes a challenging measurement problem in itself. The study also provides an approximate

[1] An alternative to *in-situ* conservation is to examine different management practices that attempt to increase the amount of CWD in forests. A cost-efficiency analysis of different practices, based on Swedish forest data, was carried out in Jonsson et al., 2005, and Ranius et al., 2005.

[2] Kniivilä (2006) estimated the WTP for preserving old-growth forests in Finland and found that nonuse values are important to both users and nonusers.

estimate of the program's opportunity cost to ensure policy relevance. The challenge of estimating the public benefits arises because many non-timber goods and services are not traded on traditional markets and, therefore, their demand function values cannot be directly estimated. Market transactions usually take place for resources that are extracted from forests (e.g., timber, berries, mushrooms and meat), but typically do not exist for non-extractive goods and services (e.g., recreation, carbon sequestration, regulation of hydrological flows, species habitat, genetic reserves).

Economic methods to value nonmarket goods that support nonuse values are typically based on stated preferences, and the most commonly applied method is contingent valuation (CV) (Mitchell and Carson, 1989). The method builds upon hypothetical markets where individuals state their preferences for certain goods or services. This is in contrast to revealed preferences methods which rely on observations about individuals' actual market behaviour. Individuals are assumed to possess neo-classical preferences and are able to value all goods, including environmental amenities, given that they are provided with relevant information.

The main advantage of the CV method is its ability to capture nonuse values, which are most often unrelated to actual market behaviour. Market methods based on weak-complementarity (Mäler, 1973), such as travel cost and hedonic studies, do not typically capture nonuse values. When nonuse values are involved, these methods likely underestimate the total value of the considered good (Freeman, 2003), which is the reason for applying the CV method in this paper.

2. Previous literature

Various goods and services related to wildlife protection and conservation of biodiversity have been valued through the application of CV, including single species, multiple species, recreational areas, and ecosystem functions and services (see Nunes and van den Bergh, 2001 for an overview). Despite its frequent application, the CV method has attracted criticism based on the potential hypothetical bias and incentive-compatibility problems (Kahneman and Knetsch, 1992; Diamond and Hausman, 1994). However, advocates of the CV method argue that these problems typically stem from a poorly-constructed study, rather than the method itself (Carson et al., 2001a; and Hanemann, 1994).[3]

[3] See Carson et al (1994) and Carson (forhcoming) for an overview of the CV literature. Sundberg and Söderqvist (2004) overviews the Swedish CV studies.

During the last decade several stated and revealed valuation studies have assessed the values attached to boreal forests in Fennoscandia[4] (see Lindhjem, 2007 for an overview). Rather than evaluating the total value of specific forest areas, Swedish studies have focused primarily on partial values such as recreation and extraction values (Bojö, 1985; Mattsson and Li, 1993, 1994; Bostedt and Mattsson, 1995; Hörnsten and Fredman, 2000); hunting values (Johansson et al., 1988; Johansson, 1990; Mattsson, 1990; Mattsson and Kriström, 1987); or conservation of single or multiple species (Broberg and Brännlund, 2007; Fredman, 1995, 2000; Johansson, 1989).

To the author's knowledge only Kriström (1990) considered the total value of forest preservation. He applied the CV method to estimate the public benefit from preserving 11 specific forest areas in different parts of Sweden, including five old-growth forests. The estimates of mean willingness to pay (WTP) were presented for both an open-ended (SEK 1023 per household[5]) and a dichotomous choice question (between SEK 200 and SEK 2500, depending on distributional assumptions). The conventional logit specification resulted in an estimate of mean WTP equal to SEK 1400. Aggregated over the number of households, the total public benefit of the proposed preservation project ranged between SEK 0.7-9.2 billion, depending on the elicitation format and model specification.[6] The study found that respondents who expressed only a use motive stated a higher WTP on average than respondents stating only a nonuse motive. Those respondents who expressed both use and nonuse motives stated the highest WTP. However, these differences were not significant.[7]

This paper applies a similar approach as used in Kriström (1990), but contributes with an analysis of regional differences in attitudes and WTP concerning the preservation of old-growth forest. It is also emphasized in this paper that some people are indifferent to the good they are suppose to value, i.e. they are not in the market for this good and, therefore, their WTP is zero. This issue has often been overlooked in the previous valuation literature and also in Kriström (1990). By estimating a spike model allowing for zero WTP, indifference is taken into consideration (Kriström, 1997).

Some CV-studies have tried to derive the value of separate forest attributes to compare the size of use and nonuse values. Johansson (1993) argue that the total value of forests cannot be separated

[4] Finland, Norway and Sweden.
[5] The open-ended question followed the discrete question in the survey and 35 percent of the respondents did not answer it and, therefore, were deleted from the sample. Two protest answers were also deleted.
[6] Conditional on non-negative WTP the lower bound estimate of the aggregated WTP, based on the open-ended question, is SEK 3.2 billion.
[7] Values correspond to the price level in 1990. To derive values in terms of the price level in 2005, the year of the survey study, multiply by 1.5.

into different part values because of path-dependency (different attributes may be compliments or substitutes, meaning that part values are dependent on the order in which they are evaluated). One way to get around the problem is to use the approach suggested in Carson et al. (2001b). They suggest an empirical framework, where the definition of use and nonuse are based on whether the values can be derived from studying market behaviour. Using the Carson et al. approach the nonuse value of old-growth forest is valued by asking people for their WTP conditioned on a "closed park" (a park without use opportunities). The use values are measured by studying actual market behaviour, e.g. expenditures associated with recreation in the studied forest. However, since the primary interest in this study is in estimating the total value of the preservation program considered, and because exclusion of users is against the Swedish law, which states every person's right to visit any forest in Sweden, conditioning on "closed parks" is not suitable and would in worst case undermine the valuation scenario. Instead, this study analyzes the importance of nonuse values by studying WTP among those who claim to be nonusers.

3. The valuation project and the survey

Sweden's total land area is approximately 41 million hectares, with fifty percent covered by boreal forests dominated by Scots pine (*Pinus Sylvestris*) and Norway spruce (*Picea Abies*). According to the *Swedish Forestry Agency,* about 18 percent of the forest area is owned by the State. Almost all of the old-growth forests in Sweden belongs to the State and are mainly concentrated in the sparsely populated sub-mountainous area in Northwestern Sweden (shaded area in Figure 1). A rather large part, 43% or 660 000 hectares, of the old-growth forests in this area was protected in 2002.

The data analyzed in this paper are based on a survey from the fall of 2005. The main objective was to study attitudes toward forest preservation among the Swedish population and ultimately to estimate the mean WTP for implementing the preservation program described above. The sample included 2,000 individuals between the ages of 18 and 84. The study relied on stratification to assure selection of individuals living in municipalities near the studied forest areas. Two strata were defined: "local", consisting of all the municipalities in the sub-mountainous region, and "non-local", consisting of all other municipalities in Sweden. Two weeks after the first mailing a reminder (not including a new survey) was sent to those who had not responded. In total, the response rate was approximately 49 percent, including 2.5 percent blank survey responses.[8] The

[8] Unfortunately, something went wrong on behalf of the printer firm. The text in some surveys was in some places worn out and in extreme cases included empty pages (rarely though). This likely reduced the response-rate. However, the distribution of bad surveys seem to have been random and is not expected to have led to any selection bias.

response rate was slightly higher in the "local" stratum (50 percent versus 48 percent). In total the dataset included 930 respondents. Four weeks after the first mailing, a telephone evaluation was conducted among non-respondents in the two strata to obtain information about potential selection bias. The non-respondents were asked why they did not answer the mail survey and also whether they would accept increased personal tax payments in exchanges for preservation of the old-growth forests. Based on the results from the telephone survey it was concluded that non-respondents did not on average state different attitudes toward the project under scrutiny and, therefore, the sample was considered as representative. [9]

In-person interviews and a pilot study were used to test and refine the questionnaire. In total 25 questions, including two WTP questions, were included in the final questionnaire. The respondents were first asked a number of "warm-up" questions regarding their relationship to forests in general, forests in the sub-mountainous region, and attitudes toward public spending on the environment. A one-page description of the valuation project followed. The respondents were given a shortened version of the information contained in the report from the *Swedish Environmental Protection Agency*. In short the respondents were given the following information about the forests: (1) they include the largest natural forest ecosystems in Western Europe (unfragmented forests); (2) they are important for the preservation of species threatened by extinction from the Swedish fauna; (3) they are important for the reindeer herding industry; and (4) they are important recreational areas and potentially important for natural tourism. The respondents were also told that public revenues from timber harvesting would be foregone and that the program may have negative effects on some people employed in the forest related sectors. Maps were attached to the survey to identify the location of the forest areas.[10] The WTP questions were preceded by a reminder that respondents should consider their budget constraint and that they, and no one else, should decide how to spend their income. Follow-up questions asked the respondents about their motives for stating a positive or non-positive WTP. The survey ended with demographic questions (e.g., age, gender, education and income).[11]

[9] The most common stated motives for not answering the survey were laziness and time constraints.

[10] The information provided to the respondents was limited and the public estimates presented in the results should be treated as an approximation. Given complete information, which rarely exists, some respondents may want to revalue the program. However, as discussed in Fisher and Krutilla (1985, p 185) uncertain people should value "the gain from being able to learn about future benefits that would be precluded by development if one does not develop initially – the gain from retaining the option to preserve or develop in the future". If we do not have all the wanted information we should value the option to procrastinate the decision to preserve or adopt commercial forestry.

[11] Besides an ordinary WTP question, the survey also included a WTP question conditioned on an income change. However, in this paper we will only focus on the ordinary WTP question.

The payment vehicle was based on increased annual tax payments during the next five year period. One argument for dividing the total payment into a number of annual payments is that it may be more familiar to the respondent compared to a single lump-sum tax.[12]
It also increases an individual's hypothetical ability to pay in accordance with her annual budget constraint.[13]

Table 1 presents descriptive statistics for the variables used in the empirical analysis. Besides socio-economic variables two dummy-variables are included, "not green" and "green", defined by answers to an attitude question concerning public environmental expenditures. The question described the relative size of different public expenditure categories, including an environmental category, and respondents were asked to state whether they thought the environmental expenditures were "too high", "fair" or "too low". If they answered "too high" or "too low" they were assessed as being "*not green*" and "*green*". In the empirical analysis these two groups are compared to the respondents who answered that the environmental expenditures were "fair".

By comparing columns 2 and 3 in Table 1 we see that individuals in the two strata differ in key characteristics of interest to the study: the share of forest owners; members of environmental non-governmental organization (*NGO*); "green" respondents; personal income and the percentage of college or university-educated respondents. Concerning these variables only the percentage of forest owners is higher within the "local" stratum.

Figure 1: Sub-mountainous area of Sweden

[12] Previous literature does not give any clear answer about what payment vehicle to adopt. However, a number of studies have shown that the choice between periodic payments and a lump-sum significantly influences the results. Carson et al. (2003) found in their pilot-study that periodic payments may cause some respondents to believe that they will be re-contracted after the stated period. Kahneman and Knetsch (1992), Rowe et al. (1992) and Stevens et al. (1997) all find evidence for a temporal embedding effect, i.e. that respondents tend to state similar values regardless of whether it is a lump-sum or a annual payment with a five year commitment.

[13] The conservation project reaches far into the future and, therefore, the stream of benefits to an individual becomes significant. By offering the respondents a payment schedule, we increase their hypothetical ability to pay without entirely relying on the capital market.

Table 2 shows that approximately 46 percent of the respondents say they are willing to contribute financially in the form of an annual tax paid over the next five years to implement the preservation program. Adjusting the sample with population weights has a minimal impact on the results. The share of respondents willing to contribute financially is slightly lower in the "local" stratum (45 percent, not shown in Table 2).

The second WTP question asked the respondents to mark the highest amount among 16 different amounts on a payment card they would be willing to pay as an annual tax increase over the next five year period. The amounts ranged between SEK 10 and 5000 ($ 1.30 and $665)[14]. Figure 2 displays the distribution of the amounts the respondents reported. As shown the distance between the amounts on the payment card increases as they become higher and the WTP distribution therefore seems to be skewed to the right.

In Table 2 we saw that a large proportion of the sample, 54 percent, reported that they are unwilling to pay for the proposed project, which means they are either indifferent or have a negative WTP. In this paper it is assumed that they are indifferent, i.e. have WTP = 0. The large number of indifferent individuals implies a spike at zero, which needs to be considered in the econometric model below. To the extent some of these respondents have a negative WTP this paper will overestimate the mean WTP. Among our 930 respondents, 139 (of which 74 were from local communities near old-growth forests) explained their non-positive WTP by stating that enough old-growth forest has already been preserved in the sub-mountainous region. However, a portion of the evaluated forests are in areas where timber harvesting may not be economically viable to the forestry sector. Therefore, the overall effects on employment are expected to be low. The main argument for not asking individuals a follow-up question regarding the amount of compensation that would make them accept the project is that it does not mimic a real market situation and may be an unfamiliar situation to respondents (Arrow, 1993).

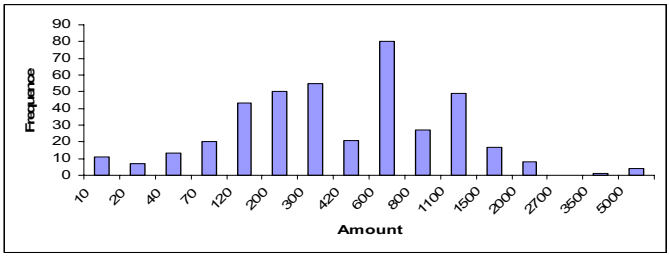

Figure 2: Frequency distribution of the highest accepted WTP amount on the payment card

[14] In November 2005, the time of the study, one dollar could be traded for 7.5 Swedish kronor (SEK).

Table 1: Descriptive statistics for the whole sample and specific strata: Mean values (standard deviation)

Variable	Whole sample (922 obs.)	Sub-mount. stratum (344 obs.)	Control stratum (578 obs.)
Age	52.87 (16.81)	54.12 (16.05)	52.14 (17.23)
Male (Yes=1)	0.5 (0.5)	0.51 (0.5)	0.49 (0.5)
Higher education (Yes=1)	0.29 (0.45)	0.25 (0.43)	0.32 (0.47)
Income (16 categories)	5.4 (3.11)	4.9 (2.46)	5.7 (3.4)
Member of Green NGO (Yes=1)	0.08 (0.27)	0.06 (0.23)	0.09 (0.29)
"Not-green"[a]	0.05 (0.21)	0.06 (0.23)	0.04 (0.19)
"Green"[b]	0.33 (0.47)	0.29 (0.45)	0.35 (0.48)
Forest owners (Yes=1)	0.24 (0.43)	0.43 (0.5)	0.14 (0.34)
Employed in forestry (Yes=1)	0.02 (0.14)	0.02 (0.14)	0.02 (0.14)
Employed in wood industry (Yes=1)	0.03 (0.17)	0.05 (0.22)	0.02 (0.13)
Single household[c]	0.25 (0.43)	0.24 (0.43)	0.25 (0.43)
No children[d]	0.23 (0.42)	0.24 (0.42)	0.23 (0.42)
Emigrated local (Yes=1)	0.04 (0.2)		0.06 (0.25)

[a]If = 1:Respondent wants the government to decrease its environmental expenditures
[b]If = 1:Respondent wants the government to increase its environmental expenditures
[c]If = 1: Respondent lives alone
[d]If = 1: Respondent has no children

Table 2: Share of sample and population exhibiting a positive attitude (WTP>0) toward further conservation of state-owned old-growth forest areas in the sub-mountainous region.

	Frequency sample	Percent sample	Frequency population (18-84 years)	Percent population
"YES" (WTP>0)	413	45.64	2 820 112	46.12
"NO" (WTP=0)	492	54.36	3 295 141	53.88
Sub-total	905	100	6 115 253	100
Missing	18	2	97 764	
Blank surveys	50	5.14	414 534	
Total	973		6 627 551	

4. The model

The welfare effect is measured in terms of equivalent surplus (ES) since the project valued is protection of existing forests. The CV method estimates the welfare change directly by asking individuals to state how much they would pay to avoid a decrease in environmental quality. Our basic modelling framework is described as follows. Denote an individual's indirect utility function as $V(y, z)$, where y is income, and z is the (public) good we want to value. Let z^{P} denote the forest after the conservation project has been implemented, and z^{UP} the harvested forest in absence of legal protection.[15]

Following Hanemann (1984) we assume the individual knows her utility function with certainty, but it may contain components unobservable to the researcher. These unobservable components are treated as stochastic. Given this, the individual will reject the project, offered at bid A, if

$$V_i(y_i, z^{UP}) + \varepsilon_i^{UP} \geq V_i(y_i - A_i, z^{P}) + \varepsilon_i^{P}, \quad (1)$$

where ε^{P} and ε^{UP} are i.i.d. random variables with zero means. Condition (1), expressed in terms of utility difference, can be written as

$$\Delta V \leq \eta, \quad (2)$$

where $\Delta V = V(y - A, z^{P}) - V(y, z^{UP})$ and $\eta = \varepsilon^{UP} - \varepsilon^{P}$.

Denoting the cumulative distribution function of η as F, the probability for accepting the project at bid A can be written as

$$\Pr(\text{“Yes”}) = 1\text{-}\Pr(\text{“No”}) = 1 - \Pr(\Delta V \leq \eta) = 1 - F(\Delta V) \quad (3)$$

The survey study used the payment card format to elicit the respondents' WTP and an interval-estimation approach (Cameron and Huppert, 1989) is applied to analyze the corresponding interval-data. The payment card implies that each respondent has checked the highest amount that she is willing to pay for the considered project and it is therefore known in which interval on the payment card her precise WTP is located. So, if A^{L} defines the highest bid the respondent accepts, and A^{U} the lowest bid she rejects (the bid after the checked one), then the maximum WTP is $A^{L} \leq WTP < A^{U}$.

[15] For convenience we suppressed prices on private goods from the expression.

As before, let 1 – $F(A)$ and F(A) be the probability for accepting and rejecting bid A. The probability that WTP is between A^L and A^U can then be written as:

$$Pr(WTP > A^L) - P(WTP > A^U) = 1 - F(A^L) - (1 - F(A^U)) = F(A^U) - F(A^L) \quad (4)$$

and the log likelihood as:

$$L^{PC} = \sum_{i=1}^{N} \ln\left[F(A_i^U) - F(A_i^L)\right] \quad (5)$$

Econometric model and data considerations

As shown in Table 2 a significant fraction of the respondents stated zero WTP. Allowing for non-zero probability at zero (or even negative) WTP can be accomplished by applying the spike model proposed by Kriström (1997).[16] Suppose there are two types of individuals; those who are indifferent to the project (WTP=0), and those who like it (WTP>0). The cumulative density function (*cdf*) can be expressed as consisting of two parts:

$$\begin{aligned} F(A) &= p \qquad \text{if } A = 0 \\ &= F(A) \quad \text{if } A > 0 \end{aligned}$$

where $F(A)$ is the *cdf* for positive WTP, and p is the probability that WTP equals zero. Figure 3 illustrates the corresponding survival function.

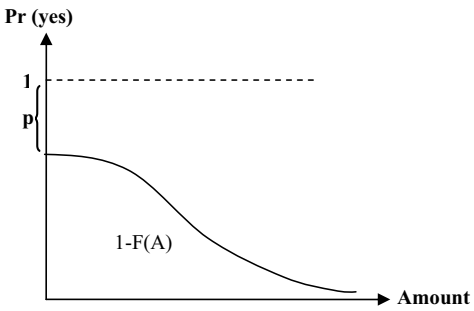

Figure 3: Survival function for the spike model

[16] Yoo & Kwak (2002) extend the DC spike model in Kriström (1997) to the case with double bounded DC. Recent applications of the spike model include Garcia & Riera (2003), Nahuelhual-Munoz et al. (2004).

By assuming a linear utility function, $V = \alpha_i + \beta y_i + \varepsilon_i$, where the error term is extreme value distributed (which implies that F(A) follows a logistically distribution), and defining Q_i as an indicator variable for individual *i* such that it equals one if she is willing to pay a positive amount, the spike version of the likelihood in the payment card case can be written as:

$$\ln L^{PC_{spike}} = \sum_1^N \left[Q_i \cdot \ln\left(F(A_i^U) - F(A_i^L)\right) + (1 - Q_i) \cdot \ln F(0) \right], \tag{6}$$

where $F(A) = (1 + e^{\tilde{\alpha} - \beta A_i})^{-1}$ and $\tilde{\alpha} = \alpha_1 - \alpha_0$..

The negative of β is interpreted as the marginal utility of income and is used to translate the utility difference into monetary terms. The parameters $\tilde{\alpha}$ and β can be estimated by maximizing the log likelihood for the entire sample, or any sub-sample, and then used to calculate the expected maximum WTP for the whole sample and for separate strata as follows:

$$WTP^{Sample} = \ln\left[1 + e^{\tilde{\alpha}}\right] / \beta \tag{7}$$

$$WTP_s = \ln\left[1 + e^{\tilde{\alpha}_s}\right] / \beta_s, \qquad s = 1,2 \tag{8}$$

To adjust for the stratified sample we calculate the mean WTP for the whole population as the weighted mean of the means in the two separate strata:

$$WTP^{Adjusted} = \sum_{s=1}^{2} (N_s / N) \cdot WTP_s \tag{9}$$

where N_s and N are the population in strata *s* and the total population.

5. Estimation of willingness to pay

Table 3 shows the results from estimation of our basic WTP model, expressed in (6). The mean WTP for the whole sample and for the separate strata is estimated to control for differences between local and non-local respondents. The first column in Table 3 shows that the respondents are, on average, willing to pay approximately SEK 300 for the preservation program's implementation. Because our estimate of the mean WTP for the whole sample is based on a stratified sample it needs to be adjusted. The weighted mean WTP for the two strata in line with (9) is SEK 287 (not shown in Table 3), which is close to the unadjusted mean. Based on a simple

t-test using the results reported in columns 2 and 3 the hypothesis of equal mean WTP in the two strata cannot be rejected. The results indicate no spatial imbalance in the distribution of public benefits derived from the preservation program.

Table 3: Estimation results from the spike-model for the whole sample and the two separate strata (standard deviations)

	Whole sample	**"Local" strata**	**"Non-local" strata**
Constant	-0.23***	-0.27**	-0.21**
	(0.07)	(0.11)	(0.08)
β	1.97***	1.80***	2.08***
	(0.07)	(0.12)	(0.09)
WTP (SEK)	296.89***	316.76***	285.44***
	(16.10)	(28.45)	(19.44)
NOBS	893	332	561
LLH	1622.72	605.34	1016.16
X^2	3245.45	1210.69	2032.32

***, **, * significant on 1,5 and 10 percent level.

The model in (6) consists of two parts, the spike and the positive side of the WTP distribution. As we saw in Table 2 a majority of the sample and the population are indifferent to the preservation program considered; that is, they belong to the spike. The median WTP is therefore zero.

The aggregated benefit, assuming a discount rate of two percent to adjust for the fact that the payment is spread over five years, amounts to approximately SEK 9.1 billion ($ 1.21 billon).[17] To give a policy-implication concerning the preservation program the aggregated benefits should be compared to the opportunity cost of foregone revenues from timber harvest. An approximation of the opportunity cost can be derived from the opportunity cost of implementing the larger preservation program, which includes the hectares evaluated in this paper, estimated in a report to the Swedish government (*The Swedish Ministry of Enterprise, Energy and Communication*, 2004). The old-growth forest in the sub-mountainous region is generally found at high altitude and relatively far from roads, and the volume timber per hectare is relatively low. This implies that the old-growth forest is generally less valuable compared to other forests. An "upper-bound" for the opportunity cost of preserving the old-growth forests is derived by calculating the opportunity cost per hectare of the larger preservation program (covering 340 000 hectares) and multiplying by 126 000 hectares, which amounts to approximately SEK 3.3 billion. The public benefit derived from the old-growth forest preservation program is almost three times higher than its opportunity cost, suggesting that its implementation is socially beneficial. The conclusion is

[17] Assuming a discount rate on five percent, results in a public benefit around SEK 8.6 billions.

based on the Kaldor-Hicks criteria, which says that a project is socially beneficial if it is possible for the "winners" to fully compensate the "losers", and therefore does not consider distributional effects. It is therefore necessary to explicitly study value determinants. The distribution of benefits is of particular interest to this study because the evaluated forests are concentrated in the same geographical area which potentially may cause a spatial imbalance.

Determinants of willingness to pay

To study determinants of the WTP two separate models are estimated: one binary logit model on the probability of observing positive WTP (the dependent variable equals one if the respondents have a positive WTP and zero otherwise) and an exponential WTP model (explaining the size of WTP, given that it is positive).[18]

The results from the binary logit model are presented in column 2 in Table 4. The results show that respondents' hypothetical choice to financially contribute to the preservation prorgam can, to some extent, be explained by personal characteristics and is not determined by a random process. Males are significantly less likely to possess a positive WTP, and the likelihood decreases with age for both males and females. Education, income and membership in any environmental NGO correlate positively with the likelihood of observing a positive WTP. Respondents who share the opinion that the government should increase (decrease) its expenditure on the environment, are significantly more (less) likely to have a positive WTP for our preservation project than those who are satisfied with the current expenditure. This result indicates that a respondent's attitude toward the environment as a whole is important for her attitude toward the preservation program. Finally, local respondents are significantly more likely to possess a positive WTP after controlling for whether they are employed in forest-related industries. The distributional problem does not seem to be between locals and non-locals, but rather between people employed in forest related sectors and others.

The results from the exponential WTP model, assuming that WTP is distributed log-normally, are presented in column 3 in Table 4. It includes a different set of explanatory variables than included in the binary logit model. The excluded variables were assessed as being statistically insignificant to the model's data fit based on a likelihood-ratio test and not expected to be important determinants of the size of WTP. As shown, only four variables are statistically significant. The bid parameter is a measure of cost-sensitivity and it is negative, as expected. The higher the bid,

[18] Another approach would have been to include covariates in equation (6). By estimating two separate models we allow the same factor to have a different influence on the probability of observing a positive WTP than on the size of WTP. The exponential WTP model was popularized by Cameron and James (1986).

the less likely the respondents are to accept it. The income parameter is also positive, which indicates that respondents are more likely to accept higher bids as their income increases. However, the income-effect is smaller for single-households. The most obvious explanation for this result is that the personal income may enforce a tighter budget constraint on single-households than on multiple-adult households. "Green" respondents have stated a significantly higher WTP than the reference group ("Fair" expenditures). As with the results from the binary logit model, respondents who are "environmentally minded" in general tend to have stronger preferences for the preservation program under scrutiny.

Locals are not found to have a significantly different WTP than non-locals. It is plausible that the total benefit from the preservation project arises mainly from nonuse vales. To study the importance of the motives underlying the respondents' valuation of the forest, I estimate an exponential WTP model, including a motive dummy. The motive dummy separates those who express both use and nonuse motives for their valuation from those who only state nonuse motives. This allows us to estimate differences in WTP between users and nonusers.[19] Based on a likelihood-ratio test all variables except the "green" dummy and income were excluded from the model. The results are presented in Table 5.

The motive dummy is highly significant and has a positive sign, as expected. The income parameter is positive, but no longer significantly different from zero. Based on the parameter estimates the mean WTP evaluated at mean income is calculated for the four possible combinations of personal characteristics. On average, users state a higher WTP than nonusers, but the results from a simple t-test do not reject the hypothesis of equal means. It is clear from the results in Table 5, which shows that non-users with a positive WTP on average value the preservation program to SEK 465-832, that the contribution of nonuse values to the total benefit of the proposed conservation program is substantial.

[19] The respondents were asked to rank, with respect to their own feelings, five statements explaining different motives for valuing the preservation program (existence value, bequest, option value, use and altruism). If her motives could not be explained by any of the statements, then she was asked to leave that statement out of the ranking.

Table 4: Binary logit on WTP>0 or WTP=0: Dependent variable equals one if respondents have WTP>0; (standard deviations).

Variable	Binary logit (WTP>0 or WTP=0)	Exponential WTP function (WTP>0)
Constant	0.57*	5.07***
	(0.32)	(0.21)
Age	-0.01*	
	(0.00)	
Male	-0.41**	
	(0.17)	
Higher Education	0.46**	
	(0.18)	
Local*wood	-1.1	
	(0.68)	
Local*forestry	-0.77	
	(0.84)	
Local	0.31*	0.11
	(0.18)	(0.13)
Emigrated local	0.37	0.00
	(0.4)	(0.25)
Forest owner	-0.31	-0.02
	(0.2)	(0.14)
Member of green NGO	1.09***	0.16
	(0.32)	(0.18)
"Not green"	-1.95***	1.38
	(0.74)	(2.59)
"Green"	1.75***	0.63***
	(0.17)	(0.11)
Individual income	0.05*	0.04**
	(0.03)	(0.02)
Income*single household		-0.04*
		(0.02)
No children		0.06
		(0.12)
Ln bid (σ)		-0.95***
		(0.03)
NOBS	841	383
LLH	-475.58	-947.75
LLH Restricted	-580.38	0
X^2	209.38	1895.508
McFadden's R^2	0.18	

***, **, * significant on 1,5 and 10 percent level.

Table 5: Exponential WTP model with motive-dummy (standard deviation for parameter and 80 percent confidence interval for WTP).

Variable / WTP	Exponential WTP model: Use and nonuse
Constant	5.04*** (0.18)
Ln bid	-0.94*** (0.03)
"Green"	0.55*** (0.11)
Income	0.03 (0.02)
Motive dummy (1=Both use and non-use)	0.22** (0.11)
WTP Nonusers and not "green"	465 (400-537)[a]
WTP Users and not "green"	580 (509-654)
WTP Nonusers and "green" (SEK)	832 (708-968)
WTP Users and "green" (SEK)	1048 (909-1189)
NOBS	397
LLH	-986.46
X^2	1972.92

***, **, * significant on 1, 5 and 10 percent level.
[a] Confidence intervals derived by Krinsky and Robb simulation.

6. Discussion and concluding remarks

This paper estimates the mean WTP for preserving an additional 126 000 hectares of state-owned old-growth forest in the sub-mountainous region of Sweden. In addition to constituting habitats for many species, the forests also provide recreational and commercial values. The objective with this study is to estimate the total value of all relevant non-timber benefits these forests provide the public in Sweden. We use the contingent valuation approach to capture both use and nonuse values attached to the proposed preservation program.

A majority of the Swedish population say they are indifferent to the preservation program, which implies that the median WTP is zero. We estimate a spike model allowing for zero WTP to estimate the mean WTP for implementing the program. On average the respondents stated a WTP of approximately SEK 290 ($ 38) per year, conditioned on a five year commitment. To test for differences in WTP between locals and non-locals, we estimate the same model on the two separate strata in our sample. The results indicate no significant difference.

According to our estimates of WTP as a five year payment commitment (and a two percent discount rate), the aggregated public benefit amounts to approximately SEK 9.1 billion ($ 1.21 billon). An approximation of the program's opportunity cost is SEK 3.3 billion, and based on the Kaldor-Hicks potential compensation criteria the program is socially beneficial and should be implemented. The estimated value of the public benefit from the proposed preservation program should be seen as an indicator of magnitude, rather than an exact value.

This paper identifies two reasons why the estimated public benefits may be a lower bound of the program's true value. First, some respondents that hold a positive value for the project may have stated zero WTP to protest against the payment vehicle or some other feature of the valuation scenario. The occurrence of these observations implies that the true WTP would be underestimated. Second, some of the benefits attached to the program may be difficult for individuals to assess. For example, Nunes and van den Bergh (2001) and Christie et al. (2006) point out that people may have difficulties with understanding issues, such as biodiversity and other ecological services, which are infrequently encountered by the typical person. In the survey underlying this paper, we excluded detailed information about certain public benefits provided by forests (e.g. benefits from carbon sequestration, ecosystem functioning and conservation of genetic diversity useful to medical research). However, one may argue that these values may not be fully captured even if the respondents had been provided with detailed information about the consequences of harvesting old-growth forest.

A typical approach in the CV literature to validate WTP estimates is to perform a scope test (recommended by the NOAA-panel in Arrow et al., 1993). The simple logic of the test is that more of a good is preferred to less and therefore larger quantities of the environmental good should be valued higher. This paper does not perform such a test because its use has been questioned in recent studies. The problem is that the result of external scope tests may depend on the good being valued and therefore the scope test may not be a reliable validation criteria (Heberlein et al., 2005). Furthermore, Bateman et al. (2004) showed that internal scope tests are sensitive to whether the respondents know if there will be sequential goods to be valued. In their experiments and field tests it was found that when respondents were not told that there would be a second WTP question, they were more likely to fail the scope test. This result implies that internal scope tests may not be a reliable test when self-administered surveys are used because the results partly depend on whether respondents read and answer the survey question by question.

The results from the estimation of a binary logit model on the probability of observing a positive WTP indicate that variables related to the respondents' education level, income level and concern about the environment are, in general, positively correlated with the likelihood of supporting the

preservation project. On the other hand, age, being a male, and having an anti-environmental attitude towards public expenditures are all negatively correlated with the likelihood of observing a positive WTP. After controlling for whether locals were employed in forest-related industries it was found that the locals were, in general, more likely than non-locals to have a positive WTP.

The results from estimation of a valuation function conditioned on respondents with a positive WTP show that the size of an individual's contribution is explained by factors such as income, general concern about the environment, and intentions to visit the considered forests. No difference between locals and non-locals was found. However, users are, on average, willing to pay more than nonusers, which is consistent with the results in Kriström (1990). The WTP for preserving old-growth forest among non-users is substantial and, if ignored by policy makers the total public benefits will be underestimated, which may lead to a different policy outcome.

The program evaluated in this paper is similar in size to the one evaluated in Kriström (1990). The estimated values are in the same magnitude, but comparing the studies further is difficult because of important differences. First, this study only considers old-growth forests that are concentrated in the same region and ecosystem. Second, this study asks for a five year payment commitment and aggregates over individuals instead of asking for a "once-in-a-lifetime" payment and aggregating over households. Finally, this paper allows for zero WTP, following Kriström (1997), which Kriström (1990) did not.

The main conclusions drawn from the results are that the preservation program seems to be socially beneficial and, even though specific groups in local societies may be hurt more than others, there is no obvious spatial distribution issue involved in preserving state-owned old-growth forests in the sub-mountainous region of Sweden.

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On the value of large predators in Sweden: A regional stratified contingent valuation analysis

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Abstract

This paper contributes with an applied policy analysis of the predator preservation policy in Sweden. We estimate the overall mean willingness to pay (WTP) for preserving the four large predators in the Swedish fauna by applying the contingent valuation method. Using survey data from 2004 we find that 50 percent of the Swedish population is willing to contribute financially toward implementation of the predator policy package, and that the estimated overall mean WTP is approximately SEK 290. Further, we test for spatial differences in attitudes and WTP and find that respondents in Stockholm have the highest overall mean WTP, while respondents living in wolf-territories have the lowest. Our mean WTP measure is flawed with upward bias, since we cannot estimate the willingness to accept for those with clearly negative preferences regarding the predator policy package (e.g. hunters). In this paper, we set their WTP equal to zero. Thus, we cannot rule out the possibility that the mean willingness to pay is, in fact, negative, i.e. the social-value of implementing the predator policy is negative. Finally, the estimates of the overall WTP are sensitive to response-uncertainty. When the respondents indicate uncertainty about their valuation, they tend to state higher values.

Keywords: Willingness to pay; Contingent valuation; Predators; Policy analysis

1. Introduction

The background to this study can be found in the decision taken by the Swedish Parliament in 2001, concerning management of the four large predators in the Swedish fauna.[1] According to the proposition, the four large predators should be managed in a sustainable manner. Among other things this means a significant increase in the wolf population, compared to its current level. According to some estimates, survival in the long run implies more than 1000 animals. The current population is approximately 58–72 animals (Wabakken et al., 2004).[2] An intermediate goal in the policy package is that the wolf population should increase to 200 animals. Concerning the bear and lynx populations, the current levels are very close to the levels stated in the governmental proposition. The current wolverine population on the other hand, is about one half of the (assumed) viable population. According to the *Swedish Species Information Centre*, the wolf is *critically endangered*, the wolverine *endangered*, whereas the bear and the lynx is *vulnerable* (see http://www.artdata.slu.se/home.htm).

According to the *Swedish Environmental Protection Agency* the government spent approximately SEK 56.5 million in 2005 to cover costs of predation on domesticated and semi-domesticated animals. As the predator populations grow larger, this cost is likely to increase. However, besides imposing direct costs on the society, predators also influence social welfare in other ways. For example, some people may attach a positive value to the fact that the fauna develops in a "natural" way, and is affected as little as possible by human actions. Hence, if some species are a natural part of a given fauna individuals may be willing to

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[1]The four large predators are: wolf (*Canis lupus*), bear (*Ursos arctos*), wolverine (*Gulo gulo*), and lynx (*Lynx lynx*).

[2]In addition there are 20–22 wolves that are characterized as borderline wolves, i.e. wolves that lives in both Norway and Sweden (Wabakken et al., 2004).

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pay in order to protect them from extinction, if the cause of extinction is human development. Other individuals may have economic interests attached to predators, e.g. through wildlife tourism. In this paper we contribute with an applied policy analysis of the predator preservation policy in Sweden. More specifically, the objective is to estimate the public benefit from preserving the four large predators in the Swedish fauna. We employ a geographically stratified contingent valuation survey, were we use coordinates of the respondents' place of residence, which allow us to study the spatial relationship between residence and WTP. Furthermore, we also perform a sensitivity analysis of our WTP estimates, with respect to response-uncertainty, since the "good" that is to be valued may not be familiar to all respondents. To accomplish this latter objective we use a multiple bounded (MB) elicitation format (Welsh and Poe, 1998). The MB format is a double-bounded format which includes an uncertainty dimension. The method is described in detail in the next section.

The objective of estimating the social benefits of preserving the predators can be described by a two-stage process. First attitudes toward the predators are determined: are individuals in favor, indifferent, or against the predator policy? Second, given that an individual is in favor of the policy we would like to know how much she would be willing to pay to implement it.

Most previous studies, concerning preservation of the Swedish/Scandinavian predators, covers only the first stage in the process and have mainly focused on the wolf population. Examples of "attitude" studies include Kaltenborn et al. (1998, 1999), Bjerke and Kaltenborn (2002), Bjerke et al. (1998), Ericsson and Heberlein (2003), and Heberlein and Ericsson (2005). Similar studies in the US have also been done, e.g. Kellert (1985, 1991, 1996, 1999). Ericsson and Heberlein (2003) analyzed differences in attitudes toward wolves between different geographical regions in Sweden, and between hunters and non-hunters. They found that hunters have the most negative attitudes, whereas the attitudes in urban areas are the most positive. They also found that the attitudes are more negative in wolf regions than in the rest of Sweden. They conclude that even if a majority of Swedish citizens are in favor of an increasing wolf population this support is rather weak. Many individuals are indifferent to the development of the wolf population, and might become negative if "negative events" get media attention.

However, a simple referendum setting as described in the first stage above is not sufficient to determine whether the implementation of the predator policy is socially beneficial. To say something about beneficence we need to take the analysis one step further and quantify the "attitudes". For this reason a contingent valuation approach (CVM) could be undertaken to estimate the willingness to pay (WTP) for implementing the predator policy. This type of approach has been applied by Boman and Bostedt (1999) who estimated the WTP for increasing the wolf population in Sweden.[3] According to their estimates, based on a dichotomous choice question, the mean WTP for restoring a perceived viable wolf population in Sweden ranged between SEK 700 and 900 (depending on the distributional assumptions).[4] However, based on an open ended WTP question the mean WTP amounted to SEK 365. Further, they found that WTP is insensitive to scope, i.e. the respondents did not value 25 animals less than 1000 animals. Hence, the respondents seemed to value what they believed was the minimum viable population.

One important aspect not discussed in Boman and Bostedt (1999) is the differences in attitudes and WTP between locals and non-locals (i.e. people residing or not residing in wolf habitat areas). However, this aspect is the main study objective in both Duffield and Neher (1996) and Chambers and Whitehead (2003). The first study estimate the WTP for reintroducing the wolves in Yellowstone National Park, and the second estimates the benefits from protecting the wolves in Minnesota. The results from both these studies highlights the importance of considering the non-use value attached to wolves when estimating their social value. Hence, the sample should not only cover local individuals.

Ericsson et al. (2007) and Bostedt et al. (2007) uses the same survey data from 2004, based on a geographically stratified sample, to estimate the overall WTP for implementing the Swedish predator policy package in Sweden. Essentially two geographical areas are studied; one area consisting of 69 strata where all of the four large predators are present, and one stratum for the rest of Sweden. The WTP data used is elicited from a MB question, where response-uncertainty is considered. In Ericsson et al. (2007) they take advantage of the MB data by estimating a random-effects ordered probit model. This approach rests upon the assumption that the response to each new bid in the bid vector is independent of the response to previous bids, which seems to be a strong assumption (see Vossler and Poe, 2005). They find that the estimates of the overall mean WTP differ substantially between different regions, ranging between SEK 405 and 667. The results in Bostedt et al. (2007) shows the same pattern in regional differences in WTP, but the estimates are generally lower and ranges between SEK 52 and 127. Instead of estimating a random-effects ordered probit model, they use the mean of the highest value that the respondents stated that they definitely would pay as an estimate of the mean WTP. These estimates can be seen as more conservative measures of the overall mean WTP.

One important restriction in previous WTP studies of protecting predators, and unfortunately in our study to, is that negative WTP is not allowed. The argument for imposing this seemingly strange restriction is that allowance of negative WTP is afflicted with various kinds of

[3]Study based on survey data collected in 1993–94.
[4]SEK 8 is approximately equal to US $1 (December 2005).

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problems, e.g. willingness to accept does not mimic a real life market situation that is familiar to the respondents. However, McMillan et al. (2001) estimates the WTP for reintroducing the wolf in two areas in Scotland. In specific, they study how the mean WTP changes when respondents are allowed to state a negative WTP. They find that the estimates of both mean and median WTP decreases significantly, and in some cases even turn negative.

We contribute to the previous literature by using precise residing coordinates in order to study how WTP differs between regions. We believe that the growth of the wolf population drives the WTP for implementation of the whole predator policy package.[5] Hence, the stratification in Ericsson et al. (2007) and Bostedt et al. (2007) is not appropriate because they cannot study wolf territories separately. Instead they just study areas where all four predators are present and compare that to a small control group representing the rest of the country. Furthermore, their control group actually includes some wolf territories. Contrary to the cited studies we use a stratification procedure that ensures respondents residing within wolf territories, near wolf territories, major cities, other urban areas and rural areas. Hence, the spatial analysis of WTP will be more comprehensive (see Fig. 1). We also apply an estimation technique that are neither conservative nor rest upon strong and probably false assumptions.

The rest of the paper is structured as follows. In Section 2 we provide a description of the data collection procedure as well as a descriptive analysis of the data. The main objective with this descriptive part is to identify general patterns, or determinants, to the attitudes towards the decided policy package. In Section 3 we give a brief description of the underlying economic model, as well as the econometric specification of the WTP equations. In Section 4 we present the results from our econometric analysis. Finally Section 5 offers some concluding comments.

2. Survey data and descriptive statistics

The empirical analysis below is based on a survey that was mailed out in May 2004 to 4050 Swedish individuals between the ages of 18 and 84. In total 2455 individuals responded, which corresponds to a response rate of 60.9 percent. The individuals were randomly selected from the register over the Swedish total population. To ensure selection of individuals living in areas of specific interest a stratification procedure was necessary. Strata were defined in order to distinguish, from the rest of the population, individuals living in the three largest cities in Sweden, and those living close to wolf territories (habitats). In our strata definitions we distinguished between wolf territory and wolf area. We defined the former as to capture residents inside wolf territories and the latter to capture residents residing outside but close to territories.[6] Further all subpopulations, except the city strata and one stratum for individuals with uncertain coordinates, were separated into rural and non-rural strata. In total 10 strata were specified.

The main objective with the survey was to question people about their attitudes toward the four large predators in the Swedish fauna and ultimately find out whether or not the population in Sweden is in favor of the governmental predator policy. We also wanted to study the magnitude of the support in terms of WTP. The survey included 24 questions, including two standard WTP questions. Information about the respondents also included census data for various characteristics (e.g. income, gender and age).

The questionnaire started with a page informing the respondents about the preservation policy: the current size of each predator's population, and the policy's corresponding target size. This information was then followed by a number of attitudinal questions and questions revealing respondents demand for forest visits (recreation, work). The WTP questions were then asked.

The sequential WTP questions were worded as follows: 1. *"imagine that the predator policy package is important for securing the long run survival of the predators in the Swedish fauna. Implementation of it costs money. Would you be willing to contribute financially to such a project?"*; 2. *"below there are some levels of an annual tax that you will have to pay for the next 5 years for implementation of the predator policy package, which covers wolves, bears, lynx and wolverines. Mark for each amount how certain you are about paying that amount."*

The WTP questions above are conditioned on the increase of the wolf and wolverine populations specified in the predator policy. No additional guidelines, such as specific policy measures or target zones, are given. As a consequence, we leave it up to the respondents' own knowledge about the issue to guide them through the valuation process. We expect differences in personal characteristics, such as place of residence, to be correlated with the knowledge of, and relationship to, the predators. For example, as the wolf population increase new wolf territories will establish, and most likely in the same region as the old ones. People who today lives relatively near wolf territories will be more likely to live within a wolf territory in the future. Also, we expect respondents whose economy is affected by the predators, such as livestock-owners, to have better knowledge about the persisting compensating system (fence-support, predation costs) than others.

[5]The wolf is known to most people in Sweden, which probably is not true for the Wolverine. The wolves are also spread over larger parts of Sweden compared to the Wolverines, i.e. more individuals will be affected by an increasing wolf population.

[6]Respondents in the two Wolf area strata resides outside wolf territories, but within a polygon including all of the wolf territories (see Fig. 1).

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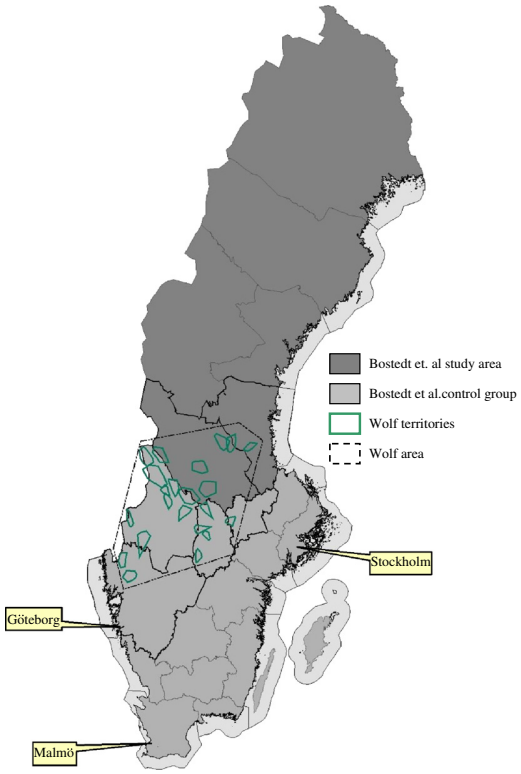

Fig. 1. Wolf territories and wolf area.

Responding to a contingent valuation question concerning a public good is no easy task. Some respondents may not be willing to put the time and effort into the exercise, or want additional information, in order to figure out a precise value. To facilitate the valuation process we employed a MB question (see Fig. 2). Each respondent were asked to respond to nine specific bids, ranging from SEK 10 to SEK 5000, how likely an actual payment of that amount would be. Five different categories were available: "definitely pay", "probably pay", "unsure", "probably not pay", "definitely not pay".

Besides facilitating the valuation task the MB format can be used to study response-uncertainty. If a respondent answers the MB question as expected to, she would ultimately be sure to pay low amounts, and then get more uncertain as the bids go up. When the bids are sufficiently high she should be sure about not wanting to pay. In such case we would have full information about the uncertainty in the respondent's answer.[7]

In Table 1 we present the share of the respondents who are in favor of the proposed predator policy and would be willing to pay for its implementation. As can be seen 38.7 percent are in favor and 61.3 percent are against or indifferent (answered "no"). Since our sample is stratified we need to weight the result from the sample data with the stratification weights to obtain the corresponding shares for the population. The adjusted population shares are

[7]As it turns out in our data 57.6 percent of the respondents who answered the MB question marked several uncertainty levels. However, a large group of the respondents, 41.6 percent, have answered the question as a payment card question and only marked one bid. The rest of the respondents in the sample are people that either (1) are sure they would pay all amounts, (2) are sure they would not pay any of the amounts or (3) provided answers that are not interpretable.

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I am willing to pay as an annual tax	Definitely Pay (DY)	Probably Pay (PY)	Unsure (U)	Probably not pay (PN)	Definitely not pay (DN)
SEK 10					
…….					
SEK 5000					

Fig. 2. The multiple bounded format.

Table 1
Willing or not willing to pay for implementation of the predator policy package, frequencies

	Frequency strat. sample	Percent strat. sample	Frequency population	Percent population
Yes	890	38.7	3 099 839	49.0
No	1408	61.3	3 223 177	51.0
Total	2298	100.0	6 323 016	100.0
Missing	144		383 986	
Total	2442		6 720 381	

Table 2
Willingness to pay or no willingness to pay for the predator policy in different areas

Stratum	Yes (%)	No (%)	Missing
Wolf area, not territory rural	32.1 (86)	67.9 (182)	7 obs.
Wolf area, not territory non-rural	40.7 (46)	59.3 (67)	7 obs.
Wolf territory, rural	23.4 (124)	76.6 (407)	26 obs.
Wolf territory, non-rural	24.2 (29)	75.8 (91)	12 obs.
Stockholm	59 (46)	41 (32)	6 obs.
Göteborg	41.1 (30)	58.9 (43)	3 obs.
Malmö	51.9 (40)	48.1 (37)	9 obs.
Rest of country, rural	45.3 (293)	54.7 (354)	52 obs.
Rest of country, non-rural	49.9 (194)	50.1 (195)	22 obs.
Total	38.7 (890)	61.5 (1416)	136 obs.

Number of observations within parenthesis.

close to each other, 49 percent is in favor and 51 percent is against or indifferent.

In Table 2 it can be seen that there is a significant difference between different strata regarding the support for the predator policy. The support is relatively small in wolf areas, and even smaller in wolf territories. It can also be seen that the support is smaller in rural areas, compared to non-rural areas. Concerning big cities there is no clear pattern. A majority in Stockholm and Malmö is clearly in favor, whereas a majority in Göteborg is not. One can only speculate what is behind the difference in stated attitudes between the major cities. One explanation could be differences in cultural variables, which affects attitudes towards non-local problems. Another explanation may be that Göteborg lies within the same county as two of the wolf territories.

As we stated in the Introduction the main objective with this paper is to study the WTP for implementing the predator policy, given that the individuals are not negative to the policy package in the first place. Unfortunately, this restriction is necessary because we do not have any information about negative WTP. However, we can indirectly identify individuals that should presumably have a negative WTP. In the survey we asked the respondents how they would like each predator population to develop at their place of residence in the future. From the answers to this question we identified those who potentially have a negative WTP for implementing the predator policy as those who stated that they want the predator populations to decrease or diminish.[8] This identification is important since individuals with negative WTP would otherwise be treated as individuals with zero WTP and, hence, biasing our estimates of the mean WTP.[9] The share of respondents with a potentially negative WTP is presented in Table 3. As can be seen 9.1 percent of the Swedish population potentially have a negative WTP, and this share is significantly higher in wolf territories compared to wolf areas. This result should be compared to Boman and Bostedt (1999), who found that the share with negative preferences, concerning only the wolf population, was 2 percent in 1994. Thus, the share here can be considered as high. However, this difference is not surprising considering the fact that the predator populations have grown rapidly, and that the public wolf-debate has become very fierce with strong opinions in both directions. From Table 3 it could further be verified that 16.8 percent, among those who are not willing to pay anything at all for implementing the predator policy package, are clearly negative to the policy, in other words approximately 83 percent with stated zero WTP are indifferent. The percentage of respondents who stated zero WTP, but potentially have a negative WTP, is largest in wolf territories.

So far we have only presented descriptive statistics conditioned on respondents' place of residence. However, there are several other characteristics that are of interest.

[8]By assumption, only respondents that stated temporary or permanent presence of wolves or wolverines at their place of residence are able to have a negative WTP for implementing the predator policy. Some respondents gave a mixed answer, e.g. stated that they want the lynx population to increase but the wolf population to decrease. In such case we used the answer to the first WTP question to determine whether or not the respondent has a potentially negative WTP.

[9]In general the respondents seem to have answered the survey honestly. We have only found 13 respondents that have not been consistent in their answers, e.g. stated that they want all predator populations to diminish but at the same time stated that they support the predator policy.

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Table 3
Percentage with preferences against the predator policy

Preference group	Total	Wolf area	Wolf territory
Percent of respondents with a potentially negative WTP (negative preferences)	9.1 (618/2442)	26 (132/395)	49.9 (357/689)
Percent of respondents with a potentially negative WTP among those who stated WTP = 0.	16.8 (618/1408)	44.8 (132/249)	70 (357/498)

Numbers adjusted for stratification. Within parenthesis we present the unadjusted numbers.

Table 4
Descriptive statistics

Characteristic	Total strat. sample	In favor	Not in favor	Negative preferences
Age	50.89 (16.78)	44.88 (15.25)	54.02 (16.6)	55.55 (16.44)
Gender (female = 0)	0.51 (0.5)	0.46 (0.5)	0.53 (0.5)	0.54 (0.5)
Share with university education	0.23 (0.42)	0.32 (0.47)	0.17 (0.38)	0.12 (0.327)
Disposable household income, SEK 1000	285.35 (166.48)	302.24 (175.15)	278.99 (158.20)	257.64 (137.63)
Share with children in household	0.43 (0.50)	0.49 (0.50)	0.40 (0.49)	0.39 (0.49)

Standard deviation within parenthesis.

Table 5
Descriptive statistics, presented in percent, for various sub-groups depending on place of residence, and preference status

	Total sample			Wolf area			Wolf territory		
	In favor	Not in favor	Neg. pref.	In favor	Not in favor	Neg. pref.	In favor	Not in favor	Neg. pref.
Dog-owner	27 (240)	18.8 (265)	18.9 (117)	24.2 (32)	16.0 (40)	16.7 (22)	32 (49)	20.7 (103)	20.7 (74)
Hound-owner	4.4 (39)	15.1 (213)	26.1 (161)	6.8 (9)	13.3 (33)	22.7 (30)	4.6 (7)	22.7 (113)	28.3 (101)
Livestock- owner	15.8 (141)	14.4 (203)	19.1 (118)	18.9 (25)	12.4 (31)	17.4 (23)	19.6 (30)	17.9 (89)	18.2 (65)
Green member	15.2 (135)	4.7 (66)	3.7 (23)	15.9 (21)	6.8 (17)	4.5 (6)	17.0 (26)	3.2 (16)	2.5 (9)
Sami village member	0.3 (3)	0.5 (7)	0.5 (3)	0.8 (1)	0	0	0	0.4 (2)	0.3 (1)
Reindeer- owner	0.2 (2)	0.4 (6)	0.6 (4)	0.8 (1)	0	0	0	0.4 (2)	0.3 (1)
Hunter	7.1 (63)	20.1 (283)	32.2 (199)	7.6 (10)	22.5 (56)	31.8 (42)	4.6 (7)	26.3 (131)	32.2 (115)
Hunter in household	8.7 (77)	18.1 (255)	26.7 (165)	12.1 (16)	18.9 (47)	27.3 (36)	12.4 (19)	24.7 (123)	27.7 (99)

The number of observations is presented within the parenthesis.

Table 4 displays descriptive statistics concerning general characteristics, such as age, gender, household composition, income, and education. The statistics are presented for the whole sample, as well as for those who "are in favor", "not in favor", and those who potentially have a negative WTP regarding implementation of the predator package.

Table 4 reveals that age and education may matter for the attitude towards the policy package. The average age is significantly lower in the group that favors the predator policy. Just as obvious is the education effect. The share of respondents with university education is highest in the group which favors the predator policy, and lowest in the group which would receive an utility loss. It also appears as if income matters. Finally, it seems like respondents belonging to households with children are more likely to support the policy. However, one has to be careful in the interpretation of these statistics. First there is a positive correlation between income and education which may be due to a causal relationship between the two. Secondly, there may be a third underlying variable causing the positive relationship between income/education and attitude, and that is place of residence. If you are highly educated you probably have relative high income and live in a city. Thus it may be the case that income and education are just "spurious" effects, and that the real determinant is place of residence. A similar reasoning can be applied to the effect of children and age which are correlated.

Table 5 provides similar descriptive statistics, but for more specific characteristics, and also differences between different strata. The table reveals a number of interesting observations. First, our expectation that hunters are more likely to be against the predator policy is confirmed. As can be seen the percentage of hunters and respondents living with hunters is higher for the "no" and "negative" group. This pattern is stronger in wolf areas and is further strengthened in wolf territories. The same pattern is found

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for hound-owners.[10] As one would also suspect the percentage of respondents that are members of green non-governmental organizations (NGOs) is higher for those supporting the policy. This result seems to be stable over the studied geographical areas. Somewhat surprising, though, is the lack of obvious patterns when it comes to non-hunting dog owners and livestock owners. It seems clear that there is no intra-altruism between dog owners. From the data it seems like dog owners are more likely to have more altruism for the predators than for hounds. Concerning reindeer owners and members of Sami-villages there are too few observations in order to say anything about the attitude towards the policy within the Sami-population.[11]

3. Willingness to pay model

The basic assumption underlying the econometric model is that each respondent's stated WTP is driven by a single WTP amount, which the respondent is uncertain about. We take advantage of the MB format by estimating a lower and a higher bound for WTP. The former bound results from a recoding of the data such that only "definitely yes" is interpreted as a "yes" and all other probability statements as "no". The later bound results from recoding such that only "definitely no" means "no" and all other responses yes. We also estimate a model that has been suggested to perform similar estimates as would be obtained by employing the payment card format (Welsh and Poe, 1998). This model results from a recoding such that "DY" and "PY" means "yes", and "U", "PN" and "DN" means "no".[12] This will be our benchmark recoding. After recoding the MB data into terms of "yes" and "no" it can be treated in the same way as ordinary double-bounded WTP data.[13]

To derive the econometric specifications for estimating the social benefits, we apply the utility difference approach assuming a linear utility function (see Hanemann, 1984). Given this approach we can express the WTP as the ratio between two parameters. In addition, the linear utility assumption implies that WTP is independent of variables that are unaltered by the project, such as income and personal characteristics. Assuming a logistic distribution and a linear utility function, $V = \alpha + \beta y$, where α is the parameter related to the public good, and β is the marginal utility of income (y), WTP can be expressed as (see Hanemann, 1984)

$$\mathrm{WTP} = \frac{\alpha}{\beta}. \tag{1}$$

Double-bounded WTP data implies that we only have to consider the highest bid the respondent accepts, and the lowest bid she does not accept. So, if we define A^{L} to be the highest "yes" bid, and A^{U} to be the lowest bid with a "no" (the bid after the checked one), the maximum WTP is $A^{\mathrm{L}} \leqslant \mathrm{WTP} < A^{\mathrm{U}}$.

In the descriptive statistics in the previous section we saw that approximately 50 percent of the respondents are not willing to pay anything at all for implementation of the policy package. Furthermore, a substantial number of those respondents are indifferent to the proposed project. For this reason it is necessary to employ a spike model which allows for non-zero probability of zero WTP. To account for the stated negative preferences for the policy package we simply exclude them from the estimation, and hence only consider the WTP for those who have a non-negative WTP.[14]

Using the spike model we let Q_i be an indicator variable for individual i such that $Q_i = 1$ if she is willing to pay a positive amount, and 0 otherwise. Then, given a distribution function $F(.)$ we can write the likelihood in the linear utility case as

$$\ln L^{\mathrm{spike}} = \sum_{1}^{N} [Q_i \ln(F(A^{\mathrm{U}}) - F(A^{\mathrm{L}})) + (1 - Q_i) \ln F(0)], \tag{2}$$

where $F(0)$ is the probability for zero WTP. Here we will assume a logistic distribution, which means that $F(A) = (1 + \mathrm{e}^{\tilde{\alpha} - \beta A_i})^{-1}$.

Since we have a stratified sample we will estimate two versions of (2):[15]

Model I: $\tilde{\alpha} = \alpha_0$
Model II: $\tilde{\alpha} = \sum_{s=1}^{9} \alpha_s D_s$, where $D_s = 1$, if an observation belongs to strata s, and 0 otherwise.

The overall mean WTP in the spike-model can then be calculated as

$$\mathrm{WTP}^{\mathrm{ModelI}} = K \ln[1 + \mathrm{e}^{\alpha_0}]/\beta, \tag{3}$$

[10] Hound = Hunting dog.

[11] The Samis are the native population in Sweden. By tradition reindeer herding is an important part of their culture. Wolves, wolverines and lynx all prey upon reindeers and hence cause costs to the reindeer owners. For this reason it would be interesting to study the attitudes toward the predator policy among the Sami population.

[12] Groothuis and Whitehead (2002) argue on empirical grounds that "I don't know" responses would turn to "no" if the respondents where pushed to give a definite answer, simply because they dislike expenditures. The same could be argued in our study concerning the "unsure" response level.

[13] Evans et al. (2003) translates the verbal probability statements into numbers, and estimate the expected mean WTP. However, we cannot take advantage of any given "translation information" for our Swedish data. At the best we could make arbitrary assumptions, but that is not very appealing.

[14] Yoo and Kwak (2002) extend the DC spike model in Kriström (1997) to the case with double bounded DC. Recent applications of the spike, and extended spike, model include Garcia and Riera (2003), Nahuelhual-Munoz et al. (2004). In our data set there is no information on willingness to accept. With such data the spike model can be extended to take this into account, (see Kriström, 1997).

[15] In order to obtain an unbiased estimate of aggregate WTP we must consider the stratification since the sample is a stratified random sample and not a random population sample.

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$$\mathrm{WTP}_s^{\mathrm{ModelII}} = K_s \ln[1 + e^{\alpha_s}]/\beta, \quad s = 1, \ldots, 9, \tag{4}$$

$$\mathrm{MWTP}^{\mathrm{Model\ II}} = \sum_{s=1}^{9} (N_s/N)\mathrm{WTP}_s^{\mathrm{Model\ II}}, \tag{5}$$

where $K = n_{\mathrm{pos}}/n$, and n_{pos} is the number of individuals in the sample that are non-negative to the policy package, K_s is the corresponding number for strata s, and N_s and N are the population in strata s and the total population respectively. Eq. (6) specifies the stratification adjusted overall mean WTP.

4. Results

The estimation results for Eq. (2), Models I and II, are presented in Table 6. Considering the estimates of the overall mean WTP for implementation of the predator policy package, the two basic modeling approaches do not differ very much. However, a slightly higher WTP exists for the model where stratification is considered. According to the results the overall mean WTP is SEK 236 and 294, respectively.

The WTP result from Model I, however, is a biased estimate of the overall mean since respondents within the areas with relatively low WTP are overrepresented, compared to the population. An illustration of the estimated WTP function is provided in Fig. 3 where we have drawn the survival function for three different strata, Stockholm, non-rural wolf territory, and rural wolf territory. Worth noticing from Fig. 3 is that the median WTP is zero within wolf territories, whereas the median is slightly positive in Stockholm.

To check the robustness of our results we perform a sensitivity analysis by relaxing the arbitrary uncertainty assumption made earlier. We made the assumption that "DY" and "PY" can be interpreted as "yes", whereas "U", "PN", and "DN" can be interpreted as "no". By altering this assumption, as described in the previous section, we can estimate lower and higher bounds of the overall mean WTP. If we define "yes" as "DY" and all other responses as "no", the overall mean WTP is estimated to SEK 186. On the other hand, if we define "yes" as all responses except "DN", the overall mean WTP is estimated to SEK 795. Thus we can view SEK 186 as a lower bound and SEK 795 as an upper bound of WTP. These bounds should be compared to the estimate from our benchmark model, which was SEK 294. The differences are much less pronounced for the estimates of the median. This is to some extent illustrated in Fig. 4, where the survival functions for the Stockholm stratum under the different assumptions concerning uncertainty are plotted.

Fig. 5 displays the confidence intervals for each stratum (95%), and they confirm, to some extent, the results above. The overall mean WTP within wolf territories and the rural wolf area, are significantly lower than the overall mean WTP in Stockholm and the rest of Sweden. In Stockholm the overall mean WTP is SEK 379 whereas it is SEK 130 in non-rural wolf territories.

In order to make a more formal test of the determinants of attitudes, we estimate a simple choice model on the probability of supporting the predator policy. Two logit specifications are considered. *Model A* where the dependent variable takes the value of one if the respondent is willing to pay for the proposed policy, and zero otherwise. *Model B* only considers individuals living in wolf areas/territories, and is a multi-nominal logit model where the dependent variable is the preference status of the respondents, i.e. if she supports, is indifferent to, or has negative preferences for the predator policy. The independent variables are the characteristics discussed above. The results are presented in Table 7.

The regression results confirm the tentative conclusions drawn from the descriptive statistics above. The patterns for the covariates seems similar for wolf strata and non-wolf strata, although many variables that are significant in explaining negative preferences are stronger in wolf strata, e.g. hunter, hunter in household, hound-owner and age. Concerning differences between regions we surprisingly find that respondents in Göteborg are less likely to support the predator policy compared to respondents in wolf areas. Another interesting feature is that there seems to be a difference between rural and non-rural areas only for respondents outside wolf territories. The probability of supporting the predator policy is lower for respondents living in rural areas. It should also be noted that although it looks like respondents living in Stockholm and Malmö are more likely to support the predator policy than respondents living in the reference region ("rest of non-rural areas") the result is not significant. Finally members of green NGO's seems to have the clearest preferences in the sense that they are in favor of the policy package.[16]

In Table 8 we present the results from estimation of a valuation function on those respondents who stated a positive WTP. As can be seen there is no difference between locals and non-locals with respect to the size of stated amounts. Hence, the spatial difference in overall mean WTP is solely driven by differences in basic attitudes (willing to pay vs. not willing to pay). However, the size of WTP for preserving predators given that it is positive to start with is not well explained. The results show that members of any environmental NGO and dog-owners have a higher WTP on average than others and that the WTP is increasing with income. On the other side pensioners have reported a significantly lower WTP than others.

[16]It should be stressed here that the results in Table 7 may be influenced by multicollinearity. This is probably prevalent in the variables relating to hunting, but does not appear to be too serious since all coefficients for the hunting variables are significant and have the expected signs. The problem seems to be more serious in the education–income case. Education is highly significant in Table 7. When income is included in the regression and education excluded the coefficient for income becomes positive and significant, but very small.

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Table 6
Estimates of mean willingness to pay

	Model I	Model II	Lower bound	Higher bound
α	−0.084 (0.052)			
β	0.00204 (0.00004)	0.00206 (0.00004)		
WTP[a]	236 (8.63)	294 (15.6)	186 (15.46)	795 (42.23)
WTP_1 territory rural		151 (14.21)	95 (9.13)	407 (37.71)
WTP_2 territory non-rural		130 (29.14)	86 (18.78)	349 (79.20)
WTP_3 wolf area rural		185 (22.88)	118 (15.00)	486 (61.19)
WTP_4 wolf area non-rural		234 (38.03)	147 (24.79)	652 (102.10)
WTP_7 Göteborg		232 (46.33)	149 (30.03)	618 (126.86)
WTP_8 Malmö		304 (52.87)	196 (33.89)	807 (142.98)
WTP_9 Stockholm		379 (56.30)	242 (36.55)	1054 (151.93)
WTP_5 rest rural		285 (17.20)	182 (11.13)	761 (46.06)
WTP_6 rest non-rural		296 (23.45)	186 (15.18)	794 (63.42)
NOBS	1666	1666	1666	1666
Log L	−3074.1	−3069.9	−3150.62	−3298.70

Standard deviations are given within parenthesis.
Lower bound = "definitely yes" is taken as a "yes" answer, whereas "probably yes", "unsure", "probably no" and "definitely no" is taken as a "no" answer.
Higher bound = "definitely yes", "probably yes", "unsure", and "probably no" is taken as a "yes" answer, whereas "definitely no" is taken as a "no" answer.
Model II = "definitely yes" and "probably yes" is taken as a "yes" answer, whereas "unsure", "probably no" and "definitely no" is taken as a "no" answer (see Table 4).
[a]WTP = $\sum_i WTP_i\ (N_i/N)$, $i = 1,\ldots, 9$, N_i is population in stratum i.

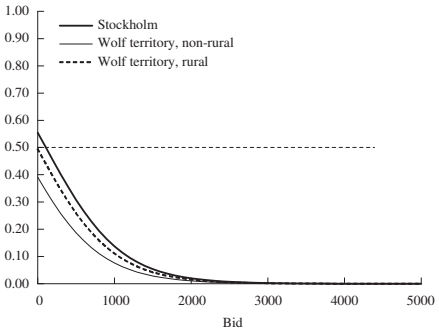

Fig. 3. Survival function for different strata.

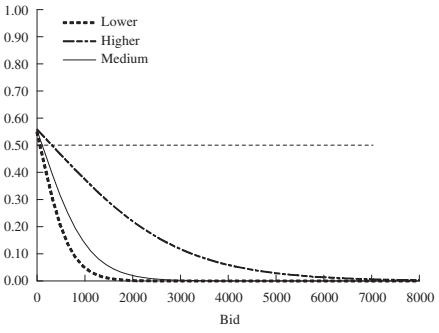

Fig. 4. Survival function for the Stockholm strata, lower and higher bound. Table 6 also reveals that the overall mean WTP for implementation of the predator policy package differs substantially between the different regions.

5. Discussion and concluding comments

The purpose of this study was to contribute with an applied policy analysis of the predator preservation policy in Sweden. The policy package under consideration implies a significant increase in the number of wolves and wolverines, and a population of bears and lynx at their current levels. Concerning this objective we find that more than 50 percent of the Swedish population is not willing to contribute financially for implementation of the predator policy. Furthermore, the results show that there is a clear "not in my backyard" effect, since the majority of policy supporters reside in big cities, far away from the predators. In wolf territories, on the other hand, two-thirds of the population reveals non-positive preferences for the policy in the sense that they are not willing to contribute economically for its implementation. Furthermore, almost one half of them clearly state that they have negative preferences for the policy. A quantitative analysis, estimating an ordinary logit model on the probability of supporting the predator policy, reveals that other factors than place of living are important determinants of the attitudes toward the predator policy. Hunters and individuals living in the same household as hunters are more

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likely to be against or indifferent to the predator policy, whereas members of green NGOs and dog-owners are more likely to be in favor.

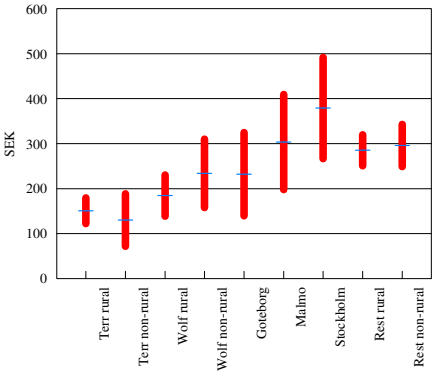

Fig. 5. Willingness to pay, 95% confidence interval.

Concerning the estimate of our welfare measure we find that it is approximately SEK 294, as a mean for the whole population, but that there are substantial differences between different parts of the country. Here it should be pointed out that our WTP measure is flawed with upward bias, since we cannot access the willingness to accept for those with clearly negative preferences. In this paper we set their WTP equal to zero. Thus, we cannot rule out the possibility that the social-value of implementing the predator policy is negative. Finally we can conclude from the sensitivity analysis concerning uncertainty that the results are fairly sensitive to how we interpret those who are uncertain. If we assume, that everyone that does not say "definitely not pay" will pay, then the mean WTP will be approximately four times higher than if we assume that those who pay are only those who say "definitely pay". Thus we can conclude that our "mean estimate" is subject to uncertainty due to "preference uncertainty".

From our results we conclude, that there is a strong significant difference in the overall mean WTP between different strata. The overall mean WTP is significantly lower in wolf territories and rural wolf areas than in the rest of Sweden, excluding Malmö, Göteborg and urban wolf areas. Furthermore it is interesting to note that the

Table 7
WTP status and preferences

	Model A	Model B	
	"Yes or No"	Indifferent	Negative
Constant	1.481*** (7.57)	−1.269*** (−3.45)	−2.626*** (−6.58)
Age	−0.071*** (−10.93)	0.028*** (4.79)	0.044*** (7.79)
Male	−0.033 (−0.69)	0.065 (0.34)	−0.093 (−0.49)
Hunter	−0.777*** (−4.3)	0.809** (2.23)	1.729*** (5.3)
Hunter in household	−0.62** (−3.67)	0.469* (1.61)	0.98*** (3.7)
Hound-owner	−0.55** (−2.41)	−0.383 (−0.87)	0.741** (2.064)
Dog-owner	0.373*** (3.17)	−0.494** (−2.19)	−0.372* (−1.79)
Green NGO	1.214*** (7.01)	−0.956*** (−3.12)	−1.798*** (−5.17)
Livestock-owner	0.067 (0.46)	−0.164 (0.61)	0.072 (0.3)
Education	0.55*** (4.87)	−0.392* (1.72)	−0.843*** (−3.61)
Rural wolf territory	−0.891*** (−5.49)	−0.055 (−0.2)	1.031*** (3.42)
Non-rural wolf territory	−0.878*** (−3.49)	0.074 (0.21)	1.002*** (2.74)
Rural wolf area	−0.594*** (−3.25)	0.001 (0.004)	0.474* (1.48)
Non-rural wolf area	−0.385* (−1.644)		
Göteborg	−0.713** (−2.54)		
Malmö	0.883 (0.32)		
Stockholm	0.668 (0.24)		
Rest of rural areas	−0.12 (−0.83)		
NOBS	2258	1010	
R^2_ML	0.185		
Pseudo-R^2	0.15	0.144	
Log L^{UR}	−1284.13	−912.44	
Log L^{R}	−1510.20	−1066.11	

t-values within parenthesis.
Model A: Lhs variable is 1 if the respondent is willing to contribute, zero otherwise. Reference group for the strata is the strata "rest of non-rural areas".
Model B: Lhs variable 0 if respondent is willing to contribute, 1 if indifferent, 2 if against the predator policy. Model 2 only include respondents within wolf areas and wolf territories.
***,**,* Significant on 1%-, 5%- and 10%-level.

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Table 8
WTP-function (*t*-values within parenthesis)

Constant	0.979*** (3.132)
Age (not pensioner)	−0.006 (−0.978)
Pensioner	−0.738** (−2.145)
Male	0.213 (2.771)
Green NGO	0.866*** (5.266)
Wolf area/territory	−0.08 (−0.503)
Stockholm	−0.041 (−0.148)
Hunter	0.143 (0.464)
Hunter in wolf area/territory	−0.068 (−0.110)
Dog-owner	0.327** (2.162)
Income per household member (SEK 1000)	0.003* (1.813)
(Income per household member)^2	−0.0002 (−0.619)
Bid	−0.003*** (49.658)
NOBS	873
Log *L*	2279.186

***,**,* Significant on 1%-, 5%- and 10%-level.

median WTP exceeds zero only in the Stockholm stratum. For a median citizen in any other region of the country WTP is at most zero.

The overall mean WTP is influenced by both the share of respondents willing to pay and their stated WTP. Our results show that, while place of residence is significantly correlated with the former factor it is not significantly correlated with the later. Hence, the spatial effect is driven by differences in basic attitudes toward implementation of the predator policy package rather than by differences in the size of stated WTP. Given that respondents have a positive WTP in the first place the size of the stated amounts are significantly correlated with a number of personal characteristics. Members of any environmental NGO and dog-owners have a higher WTP on average than others, and the WTP is increasing with income. On the other side pensioners have reported a significantly lower WTP than others. These results suggest that the WTP for preserving predators are not random numbers, but correlated to socio-economic factors and factors which relates to environmental and animal concern.

From our results it seems clear that while almost all the costs fall upon the local population the benefits from implementing the predator policy will be distributed unequally between locals and non-locals. According to the *Swedish Environmental Protection Agency* the government spent approximately SEK 56.5 million in 2005 to cover costs of predation on domesticated and semi-domesticated animals. However, from our analysis it seems like an important issue, for the Swedish government to deal with, is how to compensate other individuals than owners of livestock and reindeers that are negative towards the predator policy. This problem will be especially important if the intension is to further increase the wolf population to 1000 animals.

Future research should aim at constructing robust methods for analyzing negative WTP and develop the theoretical framework to better incorporate the workings of response-uncertainty.

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III

A new approach for analyzing multiple bounded WTP data - Certainty dependent payment card intervals

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Abstract

This paper analyzes the multiple bounded format, in which uncertainty is directly incorporated into the WTP question. A new approach for analyzing multiple bounded uncertainty data is presented. The intuition underlying the approach is that uncertain individuals would like to state their WTP as intervals rather than precise values and that the width of the intervals is determined by the degree of uncertainty. The approach is compared to the one applied in Welsh and Poe (1998) which treats uncertainty by conditioning responses on specific verbal probability statements. We argue that the conditioning approach overestimates mean and median WTP and that conditioning WTP estimates on probability statements like "probably" and "unsure" make them "fuzzy". To empirically compare the two approaches we use data from 2004 concerning implementation of a predator protection policy in Sweden. Our analysis show that the suggested approach: (1) is more intuitive; (2) better fits the data; (3) estimates mean and median WTP with better precision; (4) is less sensitive to distributional assumptions; and (5) it is better suited for policy analysis.

Keywords*: contingent valuation; preference uncertainty; elicitation format; multiple bounded; payment card; willingness to pay; predators.*

JEL-Codes: C81, Q20, Q26, Q28

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1. Introduction

Independent of the elicitation format applied, respondents answering a hypothetical willingness to pay (WTP) question face a difficult task. The underlying problem is that respondents often are unfamiliar with the good being valued or the valuation situation itself. Thus, the challenge for researchers is to provide sufficient information to the respondents so they may familiarize themselves with the valuation scenario, but to avoid imposing a time-consuming burden that overwhelms or discourages respondents. The lack of information, time, or interest causes preference uncertainty, which makes the valuation task difficult.

The method of contingent valuation (CV) has become one of the dominant nonmarket valuation methods, presumably due to its ability to capture passive-use values (Carson et al., 2001). In spite of its popularity, it has been criticized by critics who suggest that the estimated values are flawed due to hypothetical and strategic bias (Kahneman and Knetsch, 1992; Diamond and Hausman, 1994; Harrison, 2006). Several studies have found that the DC format overestimates the actual WTP, and that individuals are more likely to accept hypothetical offers from a survey rather than actual offers in a market transaction (Cummings et al., 1995; 1997). A number of studies have further shown that individuals uncertain about their WTP tend to say "yes" when answering a DC question (Champ et al, 1997; Welsh and Poe, 1998; Champ and Bishop, 2001; Vossler et al., 2003). According to these results, the WTP estimates based on CV may not reflect the true value of the studied good and may need to be adjusted.

During the last fifteen years several articles have examined preference uncertainty with several calibration techniques being suggested. These include refinements of the DC format (Li and Mattson, 1995; Ready et al, 1995; Champ et al, 1997; Wang, 1997; Loomis and Ekstrand, 1998; van Kooten et al., 2001), the multiple bounded format (Welsh and Poe, 1998; Evans et al., 2003 and Alberini et al., 2003) and the open ended format (Håkansson, 2007). In this paper we analyze methodological issues concerning the multiple bounded (MB) format introduced in Welsh and Poe (1998). A MB question is a combination of an ordinary payment card and a polychotomous choice question introduced by Ready et al. (1995). In the MB format respondents face multiple bids rather than one bid, as in a polychotomous choice question. The respondents are asked how likely an actual "yes-vote" would be by marking one of several verbal probability statements associated with each bid amount (e.g. "definitely yes", "probably yes", "unsure", "probably no" or "definitely no"). This paper contributes to the previous literature by introducing a new approach for analyzing MB data, which is not only more intuitive compared to the conventional approaches, but also, according to our results, more precise in its estimate of mean and median WTP. The underlying logic of the approach is that people uncertain about their WTP would like

to state intervals rather than specific values and that the width of the intervals is determined by the uncertainty level.

In previous studies concerning the MB format three different empirical approaches for analyzing such data have been suggested; 1) the seminal Welsh and Poe (1998) approach; 2) the probability approach applied in Evans et al. (2003); and 3) the panel approach suggested in Alberini et al. (2003) and Cameron et al. (2002).

First, the Welsh and Poe (W-P) approach recodes the probabilistic answers (e.g., "probably yes" or "probably no" etc.) into definite answers ("yes" or "no"). It follows that the MB data converts to double-bounded WTP data which can be estimated with a discrete probability model. Underlying such recoding is an assumption concerning the real meaning of the probability statements (e.g. "probably yes" means "yes" and "unsure" means "no"). The results in Welsh and Poe (1998) showed, not surprisingly, that the median and mean WTP increased as lower certainty levels were accepted as a "yes." They also compared the estimates from different recodings of the MB data to the estimates from other elicitation formats, all based on the same valuation scenario. It was found that the *probably yes model* produced similar results as the payment card and the open-ended format, whereas the results from the *unsure model* were similar to the results elicited from the dichotomous choice question.[1] The authors concluded that, given that the choice of elicitation format significantly influences the estimates of mean and median WTP, the MB format has a practical advantage because it is possible to perform a sensitivity analysis of WTP with respect to uncertainty. We will explain the W-P approach in more detail in the next section and discuss some of its drawbacks.

The second approach, suggested by Evans et al. (2003), assigns numerical probabilities to the subjective probability statements (e.g., "probably yes" means 75 percent chance of saying yes), and then creates an estimator that accommodates uncertainty on behalf of both the respondent and the researcher. This approach is potentially useful, but its weakness is its subjective translation of verbal statements into probabilities. To address this problem, they utilize behavioral research to interpret the probabilistic meaning of statements like "probably" and "maybe." The precise meaning of such words is likely to differ between individuals, between goods and over time, which makes the mapping difficult and requires continuously updated interpretations. One alternative might be to ask the respondents themselves to translate the statements into probabilities, but this works against the main purpose and strength of the MB format, which is to

[1] The *probably yes model* means that both "definitely yes" and "probably yes" are interpreted as a "yes" and all other options as a "no". In the *unsure model* "unsure" is also interpreted as "yes".

simplify the valuation task. If the individual is expected to know her WTP conditioned on a specific probability, why not ask for her expected WTP directly?

Finally, the third empirical approach is the panel approach. By treating the MB data as a panel it is possible to model the ordered structure of the data and estimate threshold values, showing at which average bid levels people switch from one uncertainty level to another. This method is an alternative way of performing the sensitivity analysis suggested by Welsh and Poe (1998). In previous MB applications equal weights has been given to "definitely yes" and "probably no" responses in the estimation of the WTP distribution and, therefore, it will overestimate the mean and median WTP. The underlying problem is that the subjective interpretation of the probability statements is not reflected in the model, i.e. the different meaning of "definitely", "probably" and "unsure" is not considered.

Besides revealing information about response uncertainty, Alberini et al. (2003) suggested that the MB format increases the efficiency of the WTP estimates compared to the dichotomous choice and payment card formats. Indeed, such efficiency improvement will be present if the responses on successive bids for each individual are not perfectly dependent, i.e. if the correlation is less than one. If the correlation is less than one, the implication is that an individual's WTP changes throughout the "bidding process" (i.e. it is not obvious that respondents who answered "no" to $10 also will answer "no" to $100). As a consequence there is information not only in the switch from "yes" to "no" as in a payment card setting, but also in the response to all other bids. Alberini et al. (2003) found that the correlation was close to zero and estimated a random valuation function on the panel data.[2]

Vossler and Poe (2005) argue against the result in Alberini et al. (2003) on both theoretical and empirical grounds. Theoretically, the correlation between responses to successive bids ought to be close to one. That is, there are no theoretical justifications for assuming that individuals "change their mind" through the bidding process. Using the same data as used in Alberini et al. (2003), they found that the correlation coefficient was close to one, indicating complete dependence, and therefore no efficiency improvement.

We use CV data from 2004 concerning protection of the four large predators in the Swedish fauna to compare our new approach to the W-P approach and the panel approach. The results support

[2] Underlying the model in Alberini et al. (2003) is the assumption that an individual's response to each specific bid in the questionnaire emerges from a separate (independent) draw from each individual's own WTP distribution rather than being driven by a single true value. The assumption is appealing when an individual is asked to value the same good at different points in time. However, when asked sequential WTP questions at the same occasion an individual who answers consistently should say no to SEK 1000 if she said no to SEK 10. Inconsistent responses are more likely to be protest answers than independent random draws from the individual's WTP distribution.

the Vossler and Poe (2005) conclusion that the correlation between an individual's responses to successive bids is close to unity and show that the estimated central values of the WTP distribution based on our new approach differs significantly from the W-P estimates.

The rest of the paper is structured as follows. In section 2 we explain preference uncertainty and how it relates to the MB format. In section 3 we give a brief description of the underlying economic models, as well as the econometric specifications of the willingness to pay models. In section 4 we describe the data collection procedure and provide a descriptive analysis of the data. In section 5 we present the results from our econometric analysis. Section 6 is devoted to concluding comments and a discussion.

2. Treatment of observations elicited from a multiple bounded question

When WTP is elicited from a MB question, the respondents are allowed to express uncertainty. The Xs' in Figure 1 illustrate the expected response pattern. Individuals are expected to become more uncertain when higher amounts are considered.

Amount (SEK)	"Definitely yes" (DY)	"Probably yes" (PY)	"Unsure" (U)	"Probably no" (PN)	"Definitely no" (DN)
10	*X*				
50	*X*				
100		*X*			
200		*X*			
400			*X*		
800				*X*	
1500				*X*	
3000					*X*
5000					*X*

Figure 1: The MB format (the Xs' illustrate a typical response pattern)

Figure 2 illustrates the trade-off facing a respondent between income and the quantity of a specific environmental amenity. The income level M_0 and the amenity level z_0 represent the status quo. If the respondent is unfamiliar with this type of trade-off, or for some other reason feels uncertain about her WTP, it means that she is not certain about the precise location of her indifference curve. Given that the increase in the amenity level is perceived as a good, it is possible to derive logical bounds for the utility space in which the respondent's indifference curve must lie. First, increasing the amenity level while holding income constant would certainly be preferable to the status quo because it corresponds to a higher utility level, i.e. such a situation is not a trade-off. Second, if the income level decreases while the amenity level is held constant,

then this would certainly not be preferable to the status quo situation. The respondent knows for certain that the indifference curve is located in the utility space bounded by the dashed lines in Figure 2. It could further be argued that the respondent knows for certain that she would trade a relatively small amount of money for a relatively large increase in the amenity level. This type of preferable trade-off is illustrated by the area between the DY-line and the horizontal dashed line. The respondent would at least be willing to pay M_0-M_L for the increase of the amenity level from z_0 to z_1. By a similar reasoning the respondent is certain that she does not want to trade a relatively large sum of money for a relatively small increase in the amenity level. This undesired trade-off is indicated by the area between the DN-line and the vertical dashed line. This means that the respondent would not be willing to pay any amount over M_0-M_U. [3]

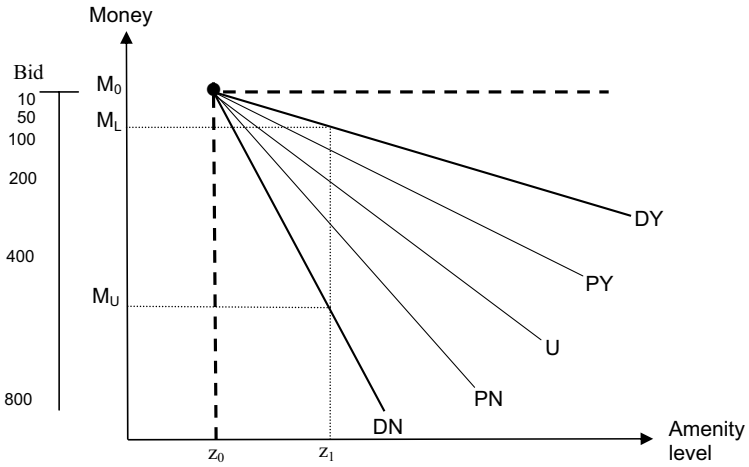

Figure 2: Preference uncertainty in a two-dimensional utility space.

For a respondent to give a good guess about the precise location of her true indifference curve she would logically want to state an interval with a lower bound equal to M_0-M_L and a higher bound equal to M_0-M_U. At some point within this interval the indifference curve has to cross the z_1 line. If we ask the respondent to state a narrower WTP interval, the respondent would be less certain that the indifference curve would fall within that interval and would answer in terms of probabilistic statements like “probably” and “unsure”.

[3] The lower bound could be understood as an implicit contract between the respondent and the researcher, where the respondent agrees to pay ”definitely” a specific amount (the highest ”definitely yes” amount). Interpretations of payment card data are discussed in Harrison and Kriström (1995).

As mentioned above, the W-P approach is based on an arbitrary recoding procedure that translates the data into "yes" and "no". Based on the example in Figure 1, four different recodings are possible: (1) DY = "yes"; (2) DY and PY = "yes"; (3) DY, PY and U = "yes"; or (4) DY, PY, U and PN = "yes." This implies that both the upper and lower bounds of the WTP interval will move upwards as the accepted certainty level decreases. For example, assume that only DY = "yes", then the WTP in Figure 1 will be in the interval [50, 100]. If both DY and PY = "yes", then the WTP will be in the interval [200, 400]. Thus, allowing for uncertainty shifts the interval upwards.

One obvious drawback with the W-P approach is that there is no obvious interpretation of the estimates to the middle responses and, therefore, their use in policy analysis is questionable. The meaning of "probably yes," "unsure" and "probably no" is heterogeneous among individuals and has to be decided by the researcher. The only certainty levels that have a clear interpretation are "definitely yes" and "definitely no". A higher bound of WTP is derived by assuming that all uncertainty levels except "definitely no" means "yes", i.e. the higher bound is bounded from below by the highest "definitely yes" amount and from above by the lowest "definitely no" amount. However, it could be useful to include uncertainty levels for cognitive reasons, i.e. middle responses may serve as means of reaching the final destination.[4]

By using the W-P approach the researcher estimates the higher bound by conditioning it on the probabilistic statements "Probably no" and "definitely no". This implies that the corresponding utility space will contain her indifference curve with some probability. It is necessary for the researcher to translate the probabilistic statement "probably no" into a real probability to scale down the estimate, otherwise the higher bound of WTP will be overestimated.[5]

Opposed to the W-P approach we suggest the intervals to be expanded rather than moved. The fundamental difference between the approaches is that the expansion approach considers uncertainty without discarding the most reliable information about each respondent's WTP, the "Definitely" responses. Applying this method in accordance with the example in Figure 1 gives the higher bound interval [50-3000], which should be compared to the corresponding W-P interval [1500-3000].

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[4] In a paper forthcoming in *Land Economics,* Hanley et al. use the payment ladder approach for eliciting WTP. The difference between the payment ladder format and the MB format is that the latter includes probabilistic statements. The method they apply corresponds to the higher bound of the expansion approach.

[5] Groothuis and Whitehead (2002) argue on empirical grounds that "I don't know" responses to dichotomous choice questions would turn to "no" if the respondents were pushed to give a definite answer, simply because they dislike expenditures. The same could be argued for the different uncertainty levels in our study. On the other hand, if pushed to give a definite answer respondents may in general pay amounts they answered "probably yes" to (which is not equivalent to "I don´t know").

When giving less of a commitment the respondent should feel more certain about her answer. In the expansion approach the respondent becomes more certain that the stated interval includes her indifference curve, because the stated interval widens. The W-P approach implies that each probability statement corresponds to a specific probability that the stated WTP interval includes the indifference curve. The weaker the probability statement is, the lower is the probability that the interval includes the indifference curve. Given the trade-off situation in Figure 2 the expansion approach seems like the more intuitive approach.

3. Econometric specifications

The theoretical foundation of the empirical model is based on the assumption that individuals derive utility from consumption of private goods, **q**, and an environmental public good, *z*. In this analysis only two levels of *z* are studied: z_0 is the initial level and z_1 is reached after implementation of the studied project. Individuals are assumed to be heterogeneous with respect to some characteristics, **X**. Furthermore they are assumed to maximize their utility, *u*, given income and commodity prices.

Let $e_i(\mathbf{p}, z, u_i)$ denote individual *i*'s expenditure function, where *u* denotes a specific utility level and **p** is a price-vector. Individual *i*'s WTP for a given change of the public good is equal to:

$$WTP_i = e_i^0\left(\mathbf{p}, z^0, u_i^0 \mid \mathbf{X}\right) - e_i^1\left(\mathbf{p}, z^1, u_i^0 \mid \mathbf{X}\right) \quad (1)$$

The probability that the respondent's WTP is higher than the offered bid amount A_i is given by:

$$\Pr("yes_i") = 1 - \Pr("no_i") = 1 - \Pr(WTP_i < A_i) \quad (2)$$

Assuming that WTP is an exponential function of a linear combination of observable characteristics and an additive stochastic term, ε, with zero mean and standard deviation, σ, yields:

$$WTP_i = e^{\mathbf{BX_i} + \varepsilon_i} \quad (3)$$

where ***B*** is a vector of parameters. Under these assumptions the probability that a respondent will accept a specific bid, A_i, is[6]:

$$\Pr("yes_i") = 1 - \Pr(\ln(A_i) - \mathbf{BX_i} > \varepsilon_i) \quad (4)$$

[6] The exponential WTP model suggests that the distribution of WTP is skewed to the right. The model was popularized by Cameron and James (1986).

Normalizing with the unknown standard deviation we get:

$$\Pr("no") = \Pr(\beta \ln(A_i) - \boldsymbol{\delta}\mathbf{X_i} > \eta_i) \tag{5}$$

where $\eta_i = \frac{\varepsilon_i}{\sigma}$, $\boldsymbol{\delta} = \frac{\mathbf{B}}{\sigma}$ and $\beta = \frac{1}{\sigma}$.

Payment card approach

We utilize a double-bounded format: each respondent's WTP is bounded by the highest bid the respondent accepts and the lowest bid she does not accept. Following Cameron and Huppert (1989) we apply an interval-estimation approach to analyze the interval-data. If we define A^L to be the highest "yes" bid, and A^U to be the lowest "no" bid, then the maximum WTP is $A^L \leq WTP < A^U$. We denote the cumulative distribution function of η as F, and let $F(A)$ be the probability of saying "yes" to bid A, and 1-$F(A)$ the probability of saying "no." The probability that the WTP lies between A^L and A^U can then be written as: $P(WTP > A^L) - P(WTP > A^U) = F(A^U) - F(A^L)$. The log likelihood is then:

$$L^{PC} = \sum_{i=1}^{N} \ln\left[F(A_i^U) - F(A_i^L)\right] \tag{6}$$

where N is the number of individuals. Under the assumption that the stochastic term is normally distributed, the parameter vector $\boldsymbol{\delta}$ and β can be estimated and then used to calculate the mean and median willingness to pay according to:

$$E[WTP] = e^{\left(\frac{\boldsymbol{\delta}\mathbf{X}}{\beta} + \frac{\sigma^2}{2}\right)} \tag{7}$$

$$Median = e^{\left(\frac{\boldsymbol{\delta}\mathbf{X}}{\beta}\right)} \tag{8}$$

4. The survey and descriptive statistics

The empirical analysis below is based on survey data from 2004. The objective of the survey was to gather information about attitudes toward the four large predators in the Swedish fauna.[7] Of the 4,050 randomly selected individuals that were sent the mail survey, approximately 61 percent returned their answers after two reminders. To ensure that individuals living in regions of specific interest were selected, we used a stratified random sample. In total, 10 strata were defined, including four wolf area strata.

Successful implementation of the Swedish government's predator policy means that the number of wolves and wolverines will increase significantly in the Swedish fauna, which can be seen as a good or a bad development, depending on one's taste. Unfortunately, the survey did not include a question about the magnitude of the compensation needed to make respondents with negative preferences indifferent to the policy. However, since our interest in this paper concerns methodological issues regarding response uncertainty we will only focus on the respondents who are in favor of implementation.[8] A more complete policy analysis of the predator policy is provided in Broberg and Brännlund (2007).

In addition to studying attitudes toward predators, the survey also included a two-part WTP question regarding implementation of the predator policy. First, respondents were asked: *"Imagine that the predator policy package is important for securing survival of the Swedish predators in the long run. Implementation of the policy costs money. Would you be willing to contribute financially to such a project?"* Those who answered yes were asked a MB question as follows: "*Below, we list several amounts of an annual tax that you will have to pay for the next five years for implementation of the predator policy package, which covers wolves, bears, lynx and wolverines. Mark for each amount how certain you are about paying that amount*." Nine bids, ranging from SEK 10 to SEK 5,000, were presented to each respondent.[9]

Table 1 summarizes the first WTP question and indicates that approximately 39 percent of the respondents were willing to contribute financially to the implementation of the predator policy. After adjusting with sample weights corresponding to the stratification, the number rises to 49 percent.

Only six respondents favoring implementation of the predator policy did not answer the MB question. However, those who did fill out the MB matrix did so in various ways. In Table 2 the

[7] The four large predators are wolf (*Canis lupus*), brown bear (*Ursus arctus*), wolverine (*Gulo gulo*) and Lynx (*Lynx lynx*).
[8] The fact that the empirical analysis only includes respondents with WTP>0 is the main argument for applying the exponential WTP model described in section 3.
[9] One US dollar could be traded for SEK 7.5 at the time of data collection in 2004.

responses to the MB question have been divided into different categories depending (primarily) on their uncertainty status and (secondarily) on whether their responses could be used directly in our empirical analysis or required individual interpretation. As shown, the majority of respondents filled out the MB matrix diagonally as expected. However, a large fraction of the respondents did not state any uncertainty, stating only "definitely yes" to one specific amount. We interpret such observations as if the WTP interval bounded by the highest amount they definitely would pay and the next amount presented to them include all the uncertainty levels. Other respondents expressed uncertainty, but not diagonally (e.g. marked "probably yes" on one amount but left all else blank). The remaining respondents answered the MB question in an inconsistent or nonsensical way. In total, seven observations were assessed as being non-usable and deleted from the sample (e.g. two respondents stated "unsure" to all nine bids).

Table 1: Willingness to contribute to implementation of the predator policy

	Frequency stratified sample	Percent stratified sample	Frequency population	Percent population
Yes	890	38.7	3 099 839	49.0
No	1 408	61.3	3 223 177	51.0
Total	2 298	100.0	6 323 016	100.0
Missing	144		383 986	
Total	2 442		6 720 381	

Table 2: MB question response quality

Response quality	Percent
Uncertainty	
1. Diagonal	54.2
2. Diagonal after being individually analyzed	2.2
3. Uncertainty indicated but not diagonal	5.5
4. Non-usable	0.8
No uncertainty	
5. Only "definitely yes" to one amount	34.3
6. Both "definitely yes" and "definitely no"	2.6

The empirical analysis is carried out on a sub-sample of the 872 respondents that stated a positive WTP, had a non-zero household income, and answered the MB question consistently. In Table 3, we present descriptive statistics on the variables that are used in the empirical analysis for our studied sub-sample and the total sample.

Table 3: Descriptive statistics for sub-sample WTP>0 and whole sample. Mean values (standard deviations).

Variable	Mean sub-sample WTP>0	Mean total sample
Age	44.84	51
	(15.25)	(16.78)
Share of retirees	0.14	0.28
	(0.35)	(0.45)
Male	0.46	0.51
(Yes=1)	(0.5)	(0,5)
Number of children in household	0.63	0.53
	(0.94)	(0.94)
Number of adults in household	1.86	1.88
	(0.81)	(0.77)
Member of green NGO	0.15	0.08
(Yes=1)	(0.36)	(0.28)
Hunter	0.07	0.15
(Yes=1)	(0.26)	(0.35)
Someone else in the household hunts (Yes=1)	0.09	0.14
	(0.28)	(0.35)
Owner of dog	0.27	0.22
(Yes=1)	(0.44)	(0.41)
Household income	304,42	285,35
(SEK)	(174,87)	(166,48)
Lower bound WTP[a]	312.56	
	(620.95)	
NOBS	872	2442

[a] The lower bound is the mean of the highest amount the respondents agreed to definitely pay.

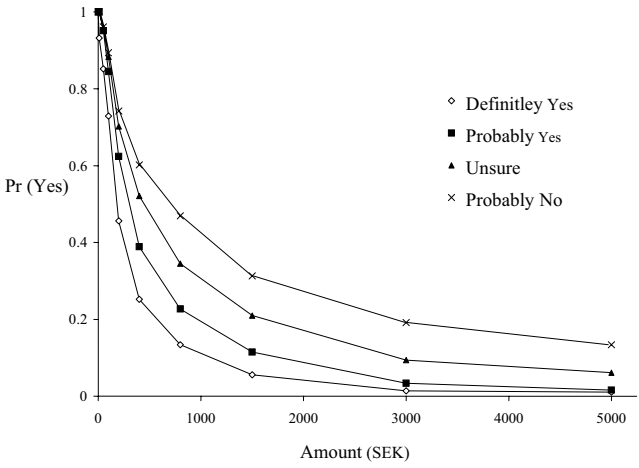

Figure 3: Survival functions corresponding to different certainty levels

An illustration of how uncertainty may influence the WTP distribution is given in Figure 3, where we have drawn non-parametric survival functions for each certainty level.[10] As expected, when lower certainty levels are interpreted as "yes" answers, respondents are willing to pay higher amounts for implementing the predator policy. Hence, more probability mass is moved towards the middle and the right tail of the corresponding probability density function.

5. The Results

In Table 4 we present the results of the comparison of the expansion and the W-P approach.[11] The certainty levels giving the lower and the higher bounds for mean and median WTP has been highlighted because we believe that they are the ones relevant for policy analysis. The other estimates are conditioned on the subjective meaning of the probability statements, and therefore do not contribute with any reliable information. The results confirm our expectation that the estimates of mean and median WTP increases as lower certainty levels are accepted as a "yes" response. However, the increase is much larger for the W-P approach which follows from the fact that it accounts for uncertainty by shifting the respondents' WTP intervals instead of expanding them.

The W-P and expansion approaches have the same lower bounds of the mean and median WTP. A non-parametric estimate for the lower bound mean WTP is given by the sample mean of the highest amount the respondents agreed to pay with certainty. As shown in Table 3 it is equal to SEK 313. By applying the interval-estimation approach described in the previous section we estimate a less conservative measure of mean (and median) WTP. In the fourth column in Table 4 we present parametric estimates, in line with equation (6), for the lower bound of WTP. The estimates of the lower bound mean and median are equal to SEK 467 and 169.

The estimates of the higher bound mean and median WTP differ substantially between the two approaches. The W-P estimate of the mean and the median are approximately 3.5 and 2 times higher compared to the estimates derived by the expansion approach. The estimates of the higher bound mean WTP are SEK 2027 (W-P) and 583 (expansion). Judging from the confidence intervals for the mean WTP, the expansion approach estimate of the higher bound mean WTP is

[10] These functions were derived by linear interpolation between different amounts on the payment card.

[11] The Alberini et al. (2003) approach has been excluded from the comparison. As was mentioned in the introduction, it only contributes substantially to the W-P approach if there are efficiency improvements to be made from treating the data as a panel. Estimation of a random effects ordered probit model reveals that the correlation between the successive responses from the same individual is approximately 0.99, suggesting that that an individual's response to each bid is driven by an underlying single WTP amount. Hence, the results imply that there are no efficiency gains from applying the panel approach.

not significantly different from the lower bound, implying that uncertainty has a modest effect on the mean WTP.

The distances between the lower and higher bound of mean and median WTP becomes much smaller using the expansion approach, which also estimates the higher bound with better precision. This can be verified by studying the confidence intervals in Table 4. It is evident that the expansion approach produces narrower confidence intervals both in absolute size and in relation to the estimated mean (i.e., the width of interval divided by the corresponding mean or median).

To further discuss the relative validity of the two approaches it can be seen in Table 4 that the influence of specific covariates differs between uncertainty models (e.g. the negative age effect gets larger as the certainty level decreases regardless of recoding approach[12]). The expansion approach leads to relatively stable effects of specific covariates, which is most obvious for the age, gender, income and $\beta=1/\sigma$ parameters.[13] It can also be verified in Table 4 that the LL-value increases as the intervals expand, but that no clear pattern exist for the W-P LL-values ("probably yes" model has the highest LL-value). These results further strengthen the notion that the W-P estimates become "fuzzy" when uncertainty is considered.

All of the estimates above were derived under the assumption that the WTP is distributed log-normally. To check the robustness of our estimation with respect to the distributional assumption, we estimate a model assuming a log-logistic distribution and find that the W-P estimates are relatively less robust.[14] Applying the W-P approach, the estimates of the higher bound mean and median WTP is SEK 5,335 and 582, which are significantly different from the estimates derived under the assumption of a log-normal WTP distribution. Under the log-logistic assumption the expansion approach results in higher bound mean and median estimates of SEK 684 and 305, which are not significantly different from the estimates derived under the log-normal assumption. In this respect the expansion approach produces relatively robust estimates.

[12]The age effect indicates that younger respondents are more uncertain than older respondents.

[13]The standard deviation is the shape parameter of the log-normal distribution and hence determines how much probability mass is found in the tails of the WTP distribution, i.e. the larger the standard deviation, the more mass in the tails.

[14]Model selection of non-nested models can be based on the Akaike information criteria: AIC=-2LL+2k, where k = the number of free parameters. Since the number of free parameter is the same regardless of the distributional assumption made this turns out to be the same as comparing the LL-values. Based on this criterion the log-normal assumption is preferred to the log-logistic assumption when estimating the higher bound. However, the LL-values are close to each other.

Table 4: Estimates of the WTP function for the Welsh and Poe and the expansion approach (t-values for parameters and 90% confidence intervals for mean and median WTP derived by Krinsky and Robb simulation).

	Welsh and Poe approach			**Lower**	***Expansion approach***		
	Higher bound[a]	Unsure[b]	Prob.yes[c]	**Bound**[d]	Prob.yes[c]	Unsure[b]	**Higher bound**[a]
Constant	4.65 (23.38)***	4.78 (23.55)***	3.75 (23.42)***	**3.38 (19.46)*****	4.63 (22.07)***	4.96 (21.93)***	5.18 (22.08)***
Age (not retired)	-0.01 (-4.85)***	-0.01 (-3.14)***	-0.004 (-1.14)	**-0.002 (-0.77)**	-0.002 (-0.65)	-0.007 (-1.96)**	-0.01 (-3.09)***
Retired	-1.34 (-8.3)***	-1.06 (-6.5)***	-0.61 (-3.77)***	**-0.36 (-2.2)****	-0.48 (-2.83 ***	-0.79 (-4.48)***	-1.07 (-5.88)***
Male	0.08 (1.08)	0.14 (1.99)**	0.19 (2.65)***	**0.17 (2.41)****	0.21 (2.76)***	0.2 (2.59)***	0.19 (2.42)**
Green NGO	0.52 (5.01)***	0.61 (6.16)***	0.58 (5.91)***	**0.46 (4.89)*****	0.6 (6.01)***	0.65 (6.22)***	0.67 (6.04)***
Wolf area	0.02 (0.28)	-0.005 (-0.06)	-0.03 (-0.4)	**-0.06 (-0.76)**	-0.05 (-0.59)	-0.04 (-0.42)	0.02 (0.22)
Stockholm	0.06 (0.41)	-0.02 (-0.13)	-0.02 (-0.16)	**-0.02 (-0.43)**	-0.05 (-0.37)	-0.03 (-0.2)	0.01 (0.06)
Dog owner	0.17 (2.18)**	0.2 (2.56)**	0.23 (2.94)***	**0.22 (2.78)*****	0.27 (3.3)***	0.26 (3.14)***	0.26 (2.96)***
Hunter	0.07 (0.34)	0.11 (0.61)	0.13 (0.78)	**0.17 (1.12)**	0.2 (1.21)	0.22 (1.26)	0.23 (1.24)
Hunter in wolf area	-0.21 (-0.54)	-0.18 (-0.47)	-0.04 (-0.1)	**0.20 (0.44)**	-0.03 (-0.08)	-0.06 (-0.14)	-0.11 (-0.27)
Household income[e]	0.001 (1.14)	0.002 (1.75) *	0.002 (2.14) **	**0.0013 (1.47)**	0.002 (2.47)**	0.002 (2.44)**	0.002 (2.29)**
(Household income)^2	-(0.00004) (-0.22)	-(0.00006) (-0.42)	-(0.0001) (-0.62)	**-(0.00007) (-0.5)**	-(0.0001) (-0.8)	-(0.0001) (-0.78)	-(0.0001) (-0.67)
(1/σ)	0.65 (34.33)***	0.76 (37.2)***	0.87 (38.49)***	**0.70 (42.73)*****	0.91 (36.13)***	0.91 (33.97)***	0.89 (32.24)***
Mean WTP	2,026.94 [1,766-2,331]	1,048.79 [943-1,165]	601.60 [552-657]	**466.66 [406-539]**	449.67 [413-491]	515.86 [471-566]	583.29 [528-646]
Median WTP	616.01 [554-681]	438.48 [401-478]	311.77 [288-337]	**169 [154-186]**	245.77 [227-266]	280.58 [259-303]	311.11 [287-338]
NOBS	872	*872*	*872*	**872**	872	872	872
LL	-1,814.39	*-1,759.18*	*-1,666.80*	**-1,771.23**	-1,270.87	-1,109.03	-1,013.36

*, **, *** significant on 1, 5 and 10-% level respectively

[a] "Definitely yes", "Probably yes" , "Unsure" and "Probably no" = **"yes";** "Definitely no" = **"no"**

[b] "Definitely yes" , "Probably yes" and "Unsure" = **"yes";** "Probably no" and "Definitely no" = **"no"**

[c] "Definitely yes" and "Probably yes" = **"yes";** "Unsure" , "Probably no" and "Definitely no" = **"no"**

[d] "Definitely yes" = **"yes";** "Probably yes", "Unsure" , "Probably no" and "Definitely no" = **"no"**

[e] Total household income, divided by the number of members in the household.

6. Discussion and concluding remarks

In this paper we study the MB format and introduce a new approach for analyzing such data. Survey data from 2004 is used to empirically compare the new approach with two approaches used in previous applications. As with Vossler and Poe (2005), we find that each respondent's answer to sequential WTP questions are driven by one single WTP amount. This finding excludes the panel approach suggested in Alberini et al (2003), which only contributes to the other methods if an individual's responses to successive bids are more or less independent.

By applying the payment card approach suggested in Welsh and Poe (1998), a lower and a higher bound can be estimated for mean and median WTP which are useful in policy analysis. Other estimates of mean and median WTP are difficult to interpret because they are conditioned on verbal probability statements. As a direct consequence of the W-P recoding procedure each individual's WTP interval moves as the probability statement changes. We argue that this procedure will overestimate the higher bound of WTP because each individual's WTP interval is conditioned on the subjective meaning of a verbal probability statement. Preference uncertainty logically implies that the respondent would like to state an interval rather than a precise value. A more intuitive approach is to expand the individuals' WTP intervals as they become more uncertain. The more uncertain the respondent is, the wider the stated interval. For this reason, expanding the intervals on the payment card is the proper way of accounting for uncertainty.

Using a non-parametric estimation procedure, we estimate the lower bound mean WTP to be SEK 313. A less conservative value is given by the parametric estimate of SEK 467. The size of the higher bound mean WTP depends on whether the W-P or the expansion approach is applied. The W-P approach results in SEK 2,027 while the expansion approach gives SEK 583. The difference reflects the fact the W-P higher bound is conditioned on an unknown probability that has not been adjusted for.

In our opinion the expansion approach: (1) is more intuitive; (2) better fits the data, as shown by our analysis of covariates and log-likelihood values; (3) estimates the higher bound mean and median WTP with better precision; and (4) is less sensitive to distributional assumption. The estimated intervals of mean and median WTP are tighter, which makes the estimates more suitable for policy analysis. If the estimated interval is too wide, policy conclusions are more difficult to reach. In future research we plan to do a Monte-Carlo study to further compare the two approaches. This will allow us to do a more stringent comparison where we ultimately can draw conclusions concerning the relative estimation efficiency of the two approaches.

By expanding the WTP intervals on the payment card the treatment of uncertainty is similar to the open-ended interval approach suggested by Håkansson (2007), where respondents have the option

to state intervals rather than precise values. By using the MB format, the researcher will have less precise information about the width of each respondent's true WTP interval, but may make the valuation task less cumbersome by presenting pre-specified intervals. As the number of bids included in the MB matrix approaches infinity, the MB format and the open-ended interval format will converge.

The usefulness of the MB format is dependent on its performance compared to other elicitation formats that account for preference uncertainty. For this reason, a comparative study could provide interesting information, especially a comparison between the MB, polychotomous choice, and the open-ended interval format. The argument in favor of the MB format is that it is a double-bounded format with a pre-specified form which gives it the potential to provide a relatively high response rate and relatively efficient estimates. Future research should as well address design issues involved in creating an optimal MB matrix (e.g. how many bids and certainty levels it should include). Design has been addressed in Roach et al. (2002) Alberini et al. (2003) and Vossler et al. (2004), but needs further investigation.

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IV

Examining the income-effect in contingent valuation
-The importance of making the right choices

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Abstract

This paper focuses on three important issues in estimating the relationship between WTP and income using contingent valuation: 1) the choice of income measure; 2) the modelling choice; and 3) the social context. Addressing the first two issues, a sensitivity analysis is performed. The results show that the estimated income-elasticity of WTP is fairly sensitive to different income measures and modelling assumptions and varies between 0.07 and 0.49 for the specific models estimated. The main conclusion drawn from the analysis is that inclusion of control variables for household characteristics is important for finding a significant income-effect, when the household income measure is used. No significant difference is found between gross or net income. The results further indicate that the relevant income measure may not only be the income level per se, but also the income level relative to others. The latter result is based on an experimental valuation question, conditioning the respondents on hypothetical changes in their absolute and relative income. The conclusion is that the social context read into the valuation situation influences the responses and, therefore, the estimated welfare measure.

Keywords*: contingent valuation; income-effect; income-elasticity of WTP; income measure; social context; relative income; multiple bounded; payment card.*

JEL-Codes: C81, Q20, Q26, Q28

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1. Introduction

Contingent valuation (CV) studies typically include income as a control variable in the willingness to pay (WTP) function to validate the results. The occurrence and size of a significant income-effect is most likely a function of the studied good, the characteristics of the sample, factors controlled for, the income measure used and the functional form applied. However, no consensus has emerged in the previous literature on how to model the relationship between WTP and income. The lack of norms makes estimation of the income-effect seemingly ad-hoc.

The relationship between WTP and income has been the subject of a fundamental discussion concerning the legitimacy of CV. A first justification test of CV estimates is to check their consistency with economic theory and *a priori* expectations. The goods and services valued in CV studies are often related to environmental quality and a strong notion within the literature has been that such goods are "luxury goods", meaning that the demand for them should increase more than proportional to income. However, the income-elasticities found in the CV literature are typically below unity (Kriström and Riera, 1996; Hökby and Söderqvist, 2003). In addition, insignificant income-effects are not unusual (Schläpfer, 2006). These results have been used to undermine the reliability of CV estimates (McFadden and Leonard, 1993; Diamond and Hausman, 1993). However, Flores and Carson (1997) showed theoretically that there is a fundamental difference between the income-elasticities of demand and WTP, where the latter, estimated by CV, is conditioned on a given quantity change.[1] In the same study it was shown that, although there exists a relationship between the two elasticities, knowledge about the size of one of them cannot be used to draw conclusions about the size of the other, i.e. an income-elasticity of WTP under unity does not disqualify a good from being a luxury. Although the income-elasticity of WTP is not sufficient to classify goods as being basic or luxury goods it reveals something about the distribution of benefits and is therefore important to study in policy analysis (Kanninen and Kriström, 1992; Kriström and Riera, 1996).

Schläpfer (2006) used meta-analysis to explore determinants of the presence of a significant income-effect in a sample of 64 CV studies including 83 valuation scenarios. A significant income-effect was found in only 30 valuation scenarios. The meta-analysis was constructed as a binary logit, where the dependent variable equaled one if a significant income-effect was reported and zero otherwise. The results showed that the probability of observing a significant income-effect was a function of several factors: (1) it increased significantly with the sample size; (2) it was significantly lower for closed-ended formats and for referendum questions; and (3) it tended to be higher for tax vehicles, especially

[1] The CV question aims at measuring the welfare effect of a given change in the quantity of the good being valued. Since the quantity change is given in the constructed market scenario individuals cannot freely maximize their utility with respect to quantity. For that reason, the demand function cannot be derived through CV.

those progressive in income. Occurrence of passive use-values attached to the valued project did not seem to be important for the probability of observing a significant income-effect. The overall conclusion from the meta-analysis was that the weak income-effect found in many contingent valuation studies may be an artifact of the survey protocol.

Wipon et al. (2004) studied the sensitivity of median WTP estimates with respect to the treatment of categorical income data and functional form.[2] The categorical income data was either recoded into dummy variables or into a continuous variable consisting of the categorical numbers or the median of the categories. The empirical analysis was based on a dichotomous choice question concerning the WTP for irradiated beef. The results showed no significant sensitivity of the WTP estimate to different treatments of the income data. The choice of functional form did neither significantly influence the estimate of median WTP as long as income was included separately and not in relation to the bid offered.[3]

This paper contributes to the previous literature on the empirical relationship between WTP and income by identifying and studying three important issues: 1) the choice of income measure; 2) the modelling choice; and 3) the social context. The first two issues are important because different choices may lead to different estimates of the income-effect. This paper performs a sensitivity-analysis of the income-effect with respect to different income measures and modelling assumptions to shed light on the importance of making the "right" choices. WTP data from 2004 concerning preservation of predators in the Swedish fauna underlies the analysis. The third issue is important to study because the social context has most often been assumed away from the valuation scenario in previous CV studies. Income per se, independent of other individuals' incomes and consumption patterns, has been judged as the relevant variable to study. The social context manifested in the relative income may play an important part since it may influence individuals' perceptions about payment responsibilities, "fair-payments" and their propensity to free-ride on other tax-payers. If that is the case, the income-effect will be determined not only by an individual's income level, but also on how it compares to the income of others. To study the importance of relative income, this paper examines WTP data concerning preservation of old-growth forest in Sweden. Specifically, I analyze the answers to an experimental WTP question that conditions respondents on hypothetical income changes.

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[2] The authors claim to have calculated the average WTP for all models estimated. According to the equations presented in their paper, it is the median that has been calculated. The median are typically found to be more robust with respect to the functional form compared to the mean, as also is found in their study.

[3] The diverging model was estimated using the log of net income ratio, i.e. $\ln\left(\frac{income - bid}{income}\right)$.

When planning a CV study the researcher needs to decide what income measures to collect. If the valuation question is directed to households, then household income seems like the reasonable measure, but this may not be the case when the question is directed to individuals. If the individuals only have control over their own personal income, then that may be the relevant income measure. The reported or registered individual or household incomes are most often "fuzzy" variables, aggregated over different income sources (e.g. work, capital and public transfers). More uncertainty is added to the analysis when the relationship between WTP and income is studied. Some households consist of several working adults and the aggregated income may not be shared equally between the household members. In such case the household income will poorly explain a specific individual's WTP. Other people may report WTP amounts that are inconsistent with their current income. For example, students and unemployed may base their WTP on expected income rather than their current income. Third, in welfare states like Sweden the reported or registered income may include all kinds of public transfers, e.g. child-support and living-support. The inclusion of transfers in the measure of income is problematic since transfers typically are assigned to cover certain expenditures, e.g. the wellbeing of children or paying the rent. By including specific control variables in the analysis some of the "fuzziness" involved in estimating the relationship between WTP and income may be reduced.

2. Modelling the relationship between WTP and income

Besides adding practical problems to the analysis, including income in the WTP function may also contribute to methodological problems. Given a continuous WTP variable (elicited from an open-ended WTP question) it is straight-forward to include income as an independent variable in the WTP regression to estimate the income-effect. If the WTP data are elicited from a dichotomous choice or a payment card question it is not as straight-forward. A common approach to handling discrete data is to set up a simple random utility model which assumes utility is linear in income (Hanemann, 1984). The linear model has great appeal since its parameters can easily be interpreted, e.g. the negative of the bid coefficient is interpreted as the marginal utility of income. Although the linear-in-income assumption is made in many studies (implying that WTP is independent of income), it is not unusual to see income in the WTP function, meaning that the theoretical model is not consistent with the model estimated.

Hanemann and Kanninen (1999) showed how income-effects can be incorporated in the random utility framework by using a Box-Cox utility function. This function is used to determine the curvature of the relationship between income and WTP. However, adoption of the Box-Cox utility function implies that income will enter the model as the difference between income and WTP, which may be problematic. Haab and McConnell (2002) argue that is not reasonable to assume that an individual's marginal utility of money varies with her own income when the project valued has a low cost. It is

therefore not justifiable to model income non-linearly in form of income-WTP. Instead it is more reasonable to assume that the marginal utility of money varies across individuals with different incomes. They suggest that income-dummies should be included in the linear random utility model to study differences in WTP between different income groups.

This paper does not aim at deriving a theoretically stringent utility model for the relationship between WTP and income. Instead the focus is on the empirical relationship. The theoretical foundation of the analysis is based on the assumption that individuals derive utility from consumption of private goods, $\boldsymbol{q}$, and an environmental public good, z. Individuals are assumed to possess a positive WTP for an increase of the public good from its initial level z^0 to the increased level z^1. Individuals are assumed to be heterogeneous with respect to some characteristics, $\boldsymbol{X}$, and income, Y. Furthermore they are assumed to maximize their utility, u, given income and commodity prices.

The empirical analysis in Section 5 is restricted to "goods", i.e. it does not consider the case of negative WTP. To address this restriction it is assumed that WTP is an exponential function of a linear combination of observable characteristics and an additive stochastic term, ε, with zero mean and standard deviation, σ.[4]

The income variable can be modeled in several ways leading to different expressions for the income-elasticity. Three common specifications for the income variable based on the exponential function are given by equations (1.a.)-(1.c.): Linear (1.a.); quadratic (1.b.); linear in logarithms (1.c.).

$$WTP_i = e^{\mathbf{BX_i}+\gamma Y_i+\varepsilon_i} \tag{1.a.}$$

$$WTP_i = e^{\mathbf{BX_i}+\bar{\gamma} Y_i+\varphi Y_i^2+\varepsilon_i} \tag{1.b.}$$

$$WTP_i = e^{\mathbf{BX_i}+\tilde{\gamma} \ln(Y_i)+\varepsilon_i} \tag{1.c.}$$

The income point-elasticity of WTP is given by:

$$I.E = \frac{dWTP}{dY} \cdot \frac{Y}{WTP} \tag{2}$$

[4] The exponential WTP model suggests that the distribution of WTP is skewed to the right. This model was popularized by Cameron and James (1986).

Taking the derivative of Eq. (1.a.) with respect to income and applying it to Eq. (2) gives:

$$I.E_{1.a} = \gamma Y \tag{3.a.}$$

where γ is the income parameter.

A non-linear relationship between WTP and the income-elasticity is derived by adding a quadratic term in the WTP function, as in Eq. (1.b.). The corresponding expression for the income-elasticity is:

$$I.E_{1.b} = \left(\tilde{\gamma} + 2\varphi Y\right) \cdot Y \tag{3.b.}$$

where φ is the parameter for the quadratic term.

Taking the logarithm of Eq. (1.c.) and then taking the derivative gives an expression for the income-elasticity, assuming that it is constant over different income levels:

$$I.E_{1.c} = \frac{d\ln(WTP)}{d\ln Y} = \tilde{\gamma} \tag{3.c.}$$

where $\tilde{\gamma}$ is the parameter for log-income.

As discussed in the previous section the income-effect and the income-elasticity may be functions of a social context, e.g. a function of the income distribution. In such cases the expressions for WTP will be more complex and involve additional parameters. The magnitude of the income-effect will be contingent not only on the absolute income, but also on the relative income. In the empirical analysis in Section 5 of this paper a simple spilt-sample approach is adopted to find out whether the social context given in the valuation scenario matters to the respondents.

3. The survey and descriptive statistics

Predator data

Several hypotheses regarding alternative income measures and WTP can be tested utilizing this dataset, which is based on a mail-survey from 2004. The basic purpose with the survey was to gather information about attitudes toward the four large predators in the Swedish fauna. The survey was mailed to 4,050 randomly selected individuals in ages 18-84 and approximately 61 percent had

returned their answers after two reminders. To ensure that individuals living in regions of specific interest would be selected, stratification was used. In addition to studying attitudes toward the predators the survey also included a two-stage willingness to pay question regarding implementation of the predator policy package. First, the respondents were asked: *"imagine that the predator policy package is important for securing survival of the Swedish predators in the long run. Implementation of the policy costs money. Would you be willing to contribute financially to such a project?"* Those who answered yes to the question were asked to answer a polychotomous-choice question formulated as: "*below are levels of an annual tax that you will have to pay for the next five years for implementation of the predator policy package, which covers wolves, bears, lynx and wolverines. Mark for each amount how certain you are about paying that amount*." Nine amounts ranging from SEK 10 to SEK 5,000 and five uncertainty levels were presented (see Figure 1).

Even if preference uncertainty is out of the scope of this study it should be dealt with since it is inherent in the MB data used. The data are recoded such that "definitely yes" and "probably yes" means "yes" and the other answers mean "no" (Welsh and Poe, 1998; Broberg and Brännlund, 2007a; 2007b). Following the approach in Broberg and Brännlund (2007b) each respondent's WTP is bounded from below by the highest amount they definitely would pay and from above by the lowest amount they are unsure about paying.[5]

Previous research on individuals' attitudes toward the predators, such as the wolf, has shown that some people perceive them as "goods" while others perceive them as "bads" (Broberg and Brännlund, 2007a; McMillan et al., 2001; Boman and Bostedt, 1999; Ericsson and Heberlein, 2003). However, this paper focuses on the relationship between income and the size of WTP and, therefore, only considers those who perceive the predators as "goods". Table 1 summarizes the answers to the first WTP question and shows that 49 percent of the Swedish population are in favour of implementation of the predator policy.

I am willing to pay as an annual tax	Definitely Pay	Probably pay	Unsure	Probably not pay	Definitely not pay
SEK 10					
…….					
SEK 5,000					

Figure 1: Multiple bounded matrix

[5] This recoding can to some degree be justified by the finding in Groothuis and Whitehead (2002), in which individuals unsure about paying a specific amount tended to answer "no" if they were pushed to give a definite answer. Welsh and Poe (1998) found that treating both "definitely yes" and "probably yes" as "yes" yields similar results as those elicited from an ordinary payment card question. However, that may not be the case in general.

The empirical analysis is carried out on the 872 respondents who stated a positive WTP and responded consistently. Table 2 presents descriptive statistics for the whole sample and the sub-sample analyzed in this paper. The income measures are individual gross and net income (including capital income) and the household disposable income (net income including capital income and social benefits).[6]

Table 1. WTP or no WTP for implementation of the predator policy package, frequencies.

	Frequency strat. sample	Percent strat. sample	Frequency population	Percent population
Yes	890	38.7	3 099, 839	49.0
No	1,408	61.3	3 223, 177	51.0
Total	2,298	100.0	6 323, 016	100.0
Missing	144		383,986	
Total	2,442		6 720, 381	

Table 2: Descriptive statistics on whole sample and sub-sample WTP>0. Mean values (Standard deviations).

Variable	Mean sub-sample WTP>0	Mean whole sample
Age	44.84 (15.25)	51 (16.78)
Male (Yes=1)	0.46 (0.5)	0.51 (0.5)
Number of children in household	0.63 (0.94)	0.53 (0.94)
Number of adults in household	1.86 (0.81)	1.88 (0.77)
Member of green NGO (Yes=1)	0.15 (0.36)	0.08 (0.28)
Owner of dog (Yes=1)	0.27 (0.44)	0.22 (0.41)
Individual gross income (SEK)	214,61 (161,70)	205,30 (154,88)
Individual net income (SEK)	145,74 (88,18)	140,31 (83,62)
Household disposable income (SEK)	304, 42 (174,87)	285 351 (166,48)
NOBS	872	2,442

[6] All income variables are from 2003. The individuals' net income was derived from the raw-data information including gross income, municipality tax-rate, progressive state tax and the tax-reduction scheme. One approximation made in the calculations regarded capital gains, which were taxed as regular income in the study. The actual tax on capital gains is 30 percent, while the income tax in different municipalities varied between 28.90 and 33.72 percent in 2004, the year of the survey study.

Old-growth forest

This dataset includes information that is used to investigate whether individuals' relative income is important to consider when eliciting WTP for public goods. The dataset concerns preservation of old-growth forests. Sweden's total land area is approximately 41 million hectares, with fifty percent covered by boreal forests dominated by Scots pine (*Pinus Sylvestris*) and Norway spruce (*Picea Abies*). According to the *Swedish Forestry Agency,* about 18 percent of the forest area is owned by the State. Almost all of the old-growth forests in Sweden belong to the state and are mainly concentrated in the sparsely populated sub-mountainous area in Northwestern Sweden (shaded area in Figure 2). A rather large part, 43% or 660,000 hectares, of the old-growth forests in sub-mountainous area was already protected in 2002. In 2002 the *Swedish Environmental Protection Agency* was commissioned by the government to assess the environmental value of the State's forests, with a focus on old-growth forests. The results from the forest assessment was published in 2004 and concluded that there were an additional 126,000 hectares (8 percent) of productive old-growth forest in the sub-mountainous region worthy of additional preservation.

A survey was sent out in the fall of 2005 with the main objective to study attitudes toward forest preservation among the Swedish population and ultimately to estimate the mean WTP for implementing the preservation program described above. The sample included 2,000 individuals between the ages of 18 and 84. The study relied on stratification to assure selection of individuals living in municipalities near the studied forest areas. In total the response rate was approximately 49 percent, including 2.5 percent blank survey responses. The dataset includes 922 consistent responses. [7]

Figure 2: Sub-mountainous area of Sweden

(Source: The Swedish environmental protection agency)

[7] Two weeks after the first mail-out a remainder was sent out. Non-respondents were contacted via telephone and asked for their reasons for not answering the mail survey. Laziness and time-constraints were the most common reasons.

In addition to an ordinary WTP question the respondents were also asked to state how they would change their WTP if their monthly income after tax would increase by SEK 1,000. A split-sample approach including two samples was adopted. Both groups (samples) were given the same information about the change of their personal income, but different information about the change in average income in Sweden.

One group was informed that the average net income per month increased by SEK 1,000, while the second group was told that the average net income per month increased by SEK 2,000. Hence, one group was contingent on an income increase that kept their relative income unchanged, while the second group was contingent on a higher absolute income, but a lower relative income. Throughout this paper the groups will be referred to as ”unchanged relative income” and ”decreased relative income”. By conditioning the respondents on a hypothetical income change, the paper aims to reveal information about respondents' perception about the relationship between income and WTP and whether the social context, manifested in the relative income, matters to their response. Table 3 presents descriptive statistics for variables used in the empirical analysis.

Broberg (2007) used the same dataset, as used in this study, and estimated the mean WTP for implementing the forest preservation program. The mean WTP based on estimation of a spike model, which allowed for zero WTP, was approximately SEK 300. The study found that the WTP was significantly correlated with income and environmental awareness. This paper analyzes the answer to the follow-up question concerning how the respondents would change their WTP given a hypothetical income change. The follow-up question was directed to respondents who stated a positive WTP, given their current budget constraint, and respondents who had zero WTP but said they were willing to pay if their budget allowed for it. Respondents who, for some other reason, stated a non-positive WTP were passed on to the next question.

Table 3: Descriptive statistics for the aggregated sample and specific samples. Mean values (standard deviation)

Variables	Whole sample (922 obs.)	”Unchanged relative income” (448 obs.)	“Decreased relative income” (474 obs.)
Age	52.87 (16.81)	53.08 (16.95)	52.68 (16.70)
Male (Yes=1)	0.50 (0.50)	0.50 (0.50)	0.49 (0.50)
Income (16 categories)	5.40 (3.11)	5.31 (2.92)	5.48 (3.28)
“Green”[a] (Yes=1)	0.33 (0.47)	0.34 (0.47)	0.34 (0.47)
Lower WTP bound (Given WTP>0)	569.34 (643.42)	546.19 (555.02)	590.52 (715.48)

[a]If = 1: Respondent wants the government to increase its environmental expenditures

The follow-up question was divided into three stages. First, the respondents were asked if they would pay anything at all given their new hypothetical budget constraint. The respondents who answered "yes" got to answer how they would change their WTP (stated earlier in the survey): "increase" "decrease" or "not change". Respondents indicating that they would change their WTP were asked to mark the highest change they would accept on a pre-specified payment card including 16 different amounts, ranging between SEK 10 and SEK 2,500. The experimental question proved to be difficult and 9.75 percent of the respondents did not answer it. The majority of the non-respondents stated a positive WTP given the first scenario, indicating that these respondents either paid less attention to the survey instructions or deliberately skipped the second valuation question after answering the first one. The amount of text in the survey may have bored and discouraged some respondents.

Table 4 presents descriptive statistics for the two groups studied concerning their responses to the follow-up question. As shown a high percentage of the respondents that stated a positive WTP given the first scenario answered that they would continue to have a positive WTP if their income would increase. However, the numbers of "no" responses are higher within the "decreased relative income" group. One reason why respondents "leave the market" when their relative economic status worsens could be that they believe that those getting relatively richer should pay more, i.e. individuals may feel that there is a relationship between social responsibility and relative standing such that the one getting relatively richer should pay more. More difficult to explain is the ten respondents in the "unchanged relative income" group that "leave the market" if the income of all citizens in the economy increases. Once again, perceptions about payment responsibility may matter, but also the perceptions about the relative growth of their personal income level. It is also possible that individuals protested against the hypothetical setting by giving seemingly strange answers.

Concerning the individuals that said they were not willing to pay given the first valuation question, only a small fraction of them increase their WTP given the hypothetical income increase. The fraction is smaller within the "decreased relative income" group. The result is interesting for two reasons. First, the relative income seems, again, to matter. Secondly, the majority of the respondents referring to their tight budget constraint when answering "no" to the valuation question did not change their answer when they were given a relatively large hypothetical income increase. One explanation for this may be that some people found it easier to refer to their budget constraint than to simply say "I don't care", i.e. they gave answers that were socially comfortable to them.

Table 4: WTP>0 if income change?
Responses for the aggregated sample and the two separate samples.

	All	"Unchanged relative income"	"Decreased relative income"
Sample size	2,000	1,000	1,000
Responses	922	448	474
Respondents with positive WTP given the initial scenario			
"Yes"	315	156	159
"No"	39	10	29
Missing	59	30	29
Total	413	196	217
Respondents with Zero WTP given the initial scenario			
"Yes"	33	20	13
"No"	228	113	120
Missing	8	6	2
Total	279	139	135

Table 5: Change in WTP in case of an increased income level.
Number of observations.

	All	"Unchanged relative income"	"Decreased relative income"
Increase	128	78	50
Decrease	13	2	11
Not change	176	73	103
Missing	31	23	8
Total	348	176	172

Table 6: Lower bound of the change in WTP contingent on an increased income level.
Mean values (standard deviations).

	All	"Unchanged relative income"	"Decreased relative income"
Increase	428.33 (435.94)	442.50 (427.82)	406.80 (451.53)
Decrease	326.15 (340.14)	440.00 (268.70)	305.45 (358.54)
Total	157.87 (364.83)	216.89 (382.66)	103.54 (339.78)
Missing	2	2	0

In Table 5 we see that many respondents would increase their WTP if their income was about to increase as described in the valuation scenario. However, a larger fraction of the respondents within the ”decreased relative income” group stated that they would leave their WTP unchanged, or even decrease it, compared to the ”unchanged relative income” group. Table 5 further indicates that respondents do react on changes in their relative standing.

Table 6 presents descriptive statistics for the payment card question concerning the highest change in WTP that the respondents would accept given the income increase. The value presented is the mean of the lower bound of the indicated change-categories. A comparison of the two groups further indicates that relative income matters to the respondents. The average increase is smaller within the ”decreased relative income” group compared to the “relative unchanged group”.

4. The econometric model

WTP model

Following Cameron and Huppert (1989) the double-bounded payment card data is analyzed by modelling the interval in which each respondent's WTP resides. If the respondent's true WTP is known to lie within an interval defined by lower and upper thresholds A_{Li} and $A_{Ui,}$ then (ln WTP_i) will lie between (*ln* A_{Li}) and *(ln* A_{Ui}), Normalizing the WTP function given in Eq. (1.a) with the unknown standard deviation (σ), the probability that (*ln* WTP_i) lies between the bounds can be written as:

$$\Pr(WTP_i \subseteq (\mathrm{A_{L\,i}}, \mathrm{A_{Ui}})) = \Pr\left[\left(\beta \cdot \ln(\mathrm{A_{L\,i}}) - \boldsymbol{\delta} X_{\mathrm{i}} - \lambda Y_i\right) < \eta_i < \left(\beta \cdot \ln(\mathrm{A_{U\,i}}) - \boldsymbol{\delta} X_{\mathrm{i}} - \lambda Y\right)\right] \quad (4)$$

where $\eta_i = \frac{\varepsilon_i}{\sigma}$, $\boldsymbol{\delta} = \frac{\mathbf{B}}{\sigma}$, $\lambda = \frac{\gamma}{\sigma}$ and $\beta = \frac{1}{\sigma}$.

If we let F(η) denote the cumulative density function, then for any given observation Eq. (4) can be rewritten as:

$$\Pr(WTP_i \subseteq (\mathrm{A_{L\,i}}, \mathrm{A_{Ui}})) = F(\eta_{Ui}) - F(\eta_{Li}) \quad (5)$$

The log-likelihood function is:

$$L = \sum_{i=1}^{N} \ln\left[F(\eta_{Ui}) - F(\eta_{Li})\right] \quad (6)$$

Estimation of Eq. (6) assuming a specific distribution for F(η) gives estimates of the parameters $\boldsymbol{\delta}$ and β which can be used to calculate the mean WTP.

Modelling change of WTP

To analyze the change in WTP following the hypothetical income change, a similar interval estimation approach is applied. The change in WTP is modelled as a linear combination of personal characteristics, a dummy for the hypothetical change in average income, DY_A (equals one if respondents belong to the "decreased relative income" group and zero otherwise) and an additive stochastic term, υ^c:

$$\Delta \mathrm{WTP_i}\,|_{\Delta Y_i} = \alpha_c + \theta \cdot X_i + \mu \cdot DY_A + \upsilon_i^c \tag{7}$$

An individual will reject a tax increase (ΔA_i) if it is larger than the change in WTP following the change in income. Hence;

$$\Pr(\Delta \mathrm{WTP_i}\,|_{\Delta Y_i} < \Delta \mathrm{A_i}) = \Pr(\alpha_c + \theta \cdot X_i + \mu \cdot DY_A + \upsilon^c{}_i < \Delta \mathrm{A_i}) \tag{8}$$

Denoting the cumulative distribution of the change in WTP with $F(\upsilon^c)$, Eq.(8) can be written as:

$$\Pr(\Delta \mathrm{WTP_i}\,|_{\Delta Y_i} < \Delta \mathrm{A_i}) = \mathrm{F}(\upsilon_i^c) \tag{9}$$

Hence, the probability of accepting a tax change is $1 - \mathrm{F}(\upsilon_i^c)$. The probability that ($\Delta WTP_i|_{\Delta Yi}$) lies between the bounds given by the double-bounded data (ΔA_{Li} and ΔA_{Lu}) can be written as:

$$\Pr(\Delta WTP_i\,|_{\Delta Y_i} \subseteq (\Delta \mathrm{A_{Li}}, \Delta \mathrm{A_{Ui}})) = F(\eta_{Ui}^c) - F(\eta_{Li}^c) \tag{10}$$

where η^c is the standarized error term (υ^c/σ^c).

When specifying the log-likelihood function it should be considered that individuals may not want to change their WTP given the hypothetical income change and, therefore, a spike at zero WTP change is introduced that allows such answers.

The interval spike model is given by[8]:

$$L = \sum_{i=1}^{N} \left[k_i \cdot \ln\left[F(\eta_{Ui}^{c}) - F(\eta_{Li}^{c}) \right] + (1 - k_i) \cdot \ln(F(0)) \right] \qquad (11)$$

where and k_i equals one if the individual stated a positive change in WTP and zero for "no change" responses.[9]

5. Results

As mentioned above, there is no consensus in the previous literature on what income measure to use and how it should be specified in the WTP function. By estimating and comparing different models based on different income measures and modelling assumptions this paper will shed light on the variation in size of the estimated income-elasticity of WTP.[10]

Table 7 presents results based on the predator dataset. Different models based on either individual (I) or household (H) income are reported. In all the models WTP is assumed to be log-normally distributed. Model 1 is based on Eq. (1.a.) where income is included linearly, as any other variable in the exponential function, and the income-elasticity is calculated as a point-elasticity evaluated at the mean values of the variables. According to the results, the estimate of the income-elasticity based on individual income is more than twice as large as the estimate based on household income. The income-elasticity estimate based on the household income is not significantly different from zero. In Model 2, where household characteristics are controlled for and WTP is assumed to be a non-linear function of income, as in Eq. (1.b.), the pattern change. The elasticity increases for both the individual and household income, but much more in the case of the latter, which increases by more than 600 percent. Judging from the results in Table 7, using the gross or net income does not lead to significantly different estimates of the income-elasticity.

Model 3 is based on Eq. (1.c.), where it is assumed that the income-elasticity is constant over income levels. The elasticity decreases in size for both individual and household income, compared to the point-elasticity estimate given by Model 2. Model 4H is regressed on household income per household

[8] Spike models applied on WTP data allowing for zero WTP can be found in Kriström (1997) and Nahuelhual-Munoz et al. (2004). Yoo & Kwak (2002) extend the DC spike model in Kriström (1997) to the case with double bounded DC.

[9] The small number of "decrease" answers have been excluded from the analysis. This will bias the estimate of the change upwards. If the data had allowed for it, an extended spike model including such answers could have been estimated.

[10] The standard deviations for the income-elasticities were calculated using the WALD-command in LIMDEP.

member. The estimated elasticity is smaller and the data fit is worse compared to Model 2, where the number of children and adults were included as independent control variables.

To sum up the results presented so far, estimates of the income-elasticity vary over different models. The estimates range between 0.07 and 0.49. The differences between the models are almost exclusively insignificant. Judging from the t-values associated with each estimate of the income-elasticity, the non-linear point-elasticity model using household income and household characteristics performs best. The corresponding estimate is 0.49.[11] Controlling for household characteristics seems important for finding a significant income-effect, when the household income is used.

Table 7: Testing for differences between individual (I) and household (H) income and the importance of household characteristics. Parameter estimates (standard deviations).

Varibles	Model 1I Net	Model 1H	Model 2I Net	Model 2I Gross	Model 2H	Model 3I Net	Model 3H	Model 4H
Constant	4.763 (0.196)***	4.704 (0.203)***	4.963 (0.222)***	4.991 (0.230)***	4.960 (0.225)***	5.172 (0.236)***	5.118 (0.217)***	4.593 (0.216)***
Ln (bid)	-0.907 (0.025)***	-0.903 (0.025)***	-0.913 (0.025)***	-0.913 (0.025)***	-0.916 (0.025)***	-0.907 (0.026)***	-0.915 (0.025)***	-0.910 (0.025)***
Age (Not retired)	-0.003 (0.003)	-0.000 (0.003)	-0.004 (0.004)	-0.003 (0.004)	-0.003 (0.004)	-0.002 (0.004)	-0.003 (0.004)	-0.003 (0.003)
Retired	-0.503 (0.174)***	-0.374 (0.167)**	-0.554 (0.195)***	-0.543 (0.194)***	-0.502 (0.189)***	-0.516 (0.197)***	-0.519 (0.189)***	-0.521 (0.182)***
Male	0.205*** (0.076)	0.240 (0.074)***	0.202*** (0.077)	0.201*** (0.077)	0.249 (0.074)***	0.231*** (0.076)	0.252 (0.074)***	0.230 (0.074)***
Green NGO	0.597 (0.098)***	0.596 (0.099)***	0.603 (0.100)***	0.601 (0.100)***	0.596 (0.100)***	0.582 (0.103)***	0.599 (0.100)***	0.591 (0.099)***
Dog	0.249 (0.081)***	0.238 (0.081)***	0.276 (0.082)***	0.278 (0.082)***	0.283 (0.082)***	0.271 (0.083)***	0.270 (0.082)***	0.265 (0.081)***
Income	0.118 (0.042)***	0.022 (0.023)	0.238 (0.100)**	0.129 (0.046)***	0.217 (0.078)***	0.124 (0.046)***	0.303 (0.089)***	0.227 (0.092)**
Income^2			-0.020 (0.020)	-0.005 (0.004)	-0.012 (0.008)			-0.012 (0.016)
Adults			-0.088 (0.041)**	-0.091 (0.040)**	-0.271 (0.051)***	-0.087 (0.041)**	-0.237 (0.049)***	
Children			-0.017 (0.043)	-0.018 (0.043)	-0.055 (0.045)	-0.007 (0.043)	-0.046 (0.045)	
Student			-0.102 (0.142)	-0.081 (0.141)	-0.007 (0.142)	0.000 (0.000)	0.000 (0.000)	-0.062 (0.138)
Income elasticity	0.189 (0.068)***	0.073 (0.077)	0.289 (0.092)***	0.252 (0.080)***	0.487 (0.124)***	0.137 (0.050)***	0.332 (0.096)***	0.294 (0.095)***
LLI	-1,273.98	-1,276.76	-1,269.86	-1,269.84	-1,266.96	-1,247.54	-1,268.46	-1,272.06
No. Obs	872	872	872	872	872	855	872	872

*, **, *** indicates if the estimates are significant on the 10, 5 and 1 percent level

[11] The t-values reveal the significance of the income-elasticity and since all models are regressed on a large sample, the t-values are comparable.

Perceptions about the relationship between income and WTP

So far the analysis has focused on differences in WTP due to differences in respondents' absolute income levels. The low income-elasticity indicates that the distribution of the benefits attached to preserving predators in the Swedish fauna is regressive in the sense that poor people are willing to pay more as a percentage of their income than rich people. The weak income-effect, which is also found in many other CV studies, may not only be a question of how income is measured or modelled. It may actually be that some peoples' demand for the public good are independent of their income level per se and instead may be a function of their income within a social context (e.g. income positioning or perceptions about "fair payments"). To study whether peoples' WTP are sensitive to changes in their relative income level, this paper adopts the split-sample experiment outlined in Section 3.

Table 8 presents results derived from estimation of the spike model given by Eq. (11), explaining the size of the change in WTP conditioned on the hypothetical income change. The model are regressed on all the respondents who answered the split-sample question and also separately on those who said they were willing to pay given their current income. Note that this model excludes respondents that would decrease their WTP given the new scenario.[12] To study whether different types of individuals react differently to the hypothetical change in their relative income, interaction terms are included in Model 6. For example, one covariate is the respondents' WTP (given the initial scenario) which is to some degree determined by other covariates in the model (e.g. "green" and income). However, this covariate is relevant to study because it also captures factors unobservable to the researcher, e.g. attitudes and perceptions about "fair payments".[13]

Model 5 includes only one covariate and, the relative income dummy. The results for both the whole sample and the sub-sample consisting of respondents with a positive WTP show that people react significantly to the social context presented in the valuation scenario. The relative income dummy is highly significant. Model 6 includes more covariates and interaction terms to further study the of the relative income effect on the change of WTP. Table 9 presents estimates for the change of WTP contingent on the hypothetical income change. The values reported are based on the estimates of Model 6 and are the average increase in WTP for the whole sample and for those respondents who stated a positive WTP (given the initial scenario). The increase in WTP is smaller within the "decreased relative income" group. The differences between the split-sample groups are statistically significant (on the ten percent level) only for those who had stated a positive WTP (given the initial scenario).

[12] The sample includes too few such observations to estimate a extended spike model taking them into consideration. Also some of the observations are likely protest answers, e.g. those who said they would decrease their WTP given an equal change in their personal income and the average income in Sweden.

[13] There seems not to be any co-linearity problem in the model. The highest correlation coefficient is 0.16 and concerns the correlation between the variables WTP and "green".

The results for the whole sample show that the increase in WTP is positively correlated with respondents' attitudes toward public expenditures on the environment ("green"), their income and their WTP (given the initial scenario). All interaction terms are negative. Those who stated a high WTP (given the initial scenario) also stated significantly higher increases in their WTP. The size of the interaction term indicates that this effect is smaller within the "decreased relative income" group. This supports the notion that the "unobservable characteristics of respondents", captured by the WTP variable, also covers perceptions about "fair payments". Males within the "decreased relative income" group tend to state smaller increases compared to females which would indicate that males react stronger to the social context manifested in the relative income change. The estimates of Model 6b show that the results remain stable when the same model is regressed only on those who stated a positive WTP (given the initial scenario). The only estimates that change substantially are the estimates of the income parameters. Income is insignificant within the "unchanged relative income group". The sign of the interaction parameter for personal income and the relative income dummy indicates that the increase in WTP tends to be higher for rich respondents within the "decreased relative income group". The result indicates that poor respondents tend to care more about changes in their relative standing than rich people. However, this effect is not significant.

6. Discussion and Concluding remarks

As discussed in the introduction of this paper, there is no consensus in the previous literature on how to model the relationship between WTP and income, i.e. the specifications used in previous literature are seemingly ad-hoc. This paper performs a comparison between different models based on different income measures and modelling assumptions to study the variation in size of the income-elasticity of WTP. The analysis in this paper also focuses on the relevance of considering social context aspects of the valuation scenario when studying the relationship between WTP and income. Specifically, the paper analyzes the importance of respondents' relative income level.

Survey data concerning preservation of the four large predators in the Swedish fauna are used to perform a sensitivity analysis of the estimated income-elasticity with respect to different income measures and modelling assumptions. The results from the analysis show that estimates of the income-elasticity of WTP are fairly sensitive to the choices of income measure and modelling. Overall, the estimated income-elasticity varied within the range of 0.07-0.49. Higher estimates are generally associated with a larger standard deviation and the differences between the estimates are almost exclusively insignificant. The highest point-estimates are produced assuming that WTP is a non-linear function of household income. This estimate is also the most precise. In the absence of control variables regarding household characteristics, individual income yields a higher estimate compared to

household income. When the number of adults and children are controlled for the pattern is reversed. The results support the notion that it is important to control for the number of adults whenever the household income is used as an independent variable in the WTP function. Using household income per household member yields a lower estimate and worse data fit compared to the model where household characteristics were included as covariates.

When analyzing the decisions of individuals the household income needs to be adjusted for the number of adults (and perhaps children also) in the household before it can be compared to the income of single households. If household characteristics are not controlled for, the household income will reveal little about the income disposable to a specific household member. This conclusion is to some degree contrary to the conjecture in Kriström and Riera (1996), that inclusion of covariates in the WTP function does not change the estimated income-elasticity in any fundamental way.

To study the importance of relative income, this paper applies a split-sample approach, using survey data concerning preservation of old-growth forest in Sweden. An experimental CV question asked respondents how they would change their WTP (stated earlier in the survey) if their absolute income and the average income in Sweden were to increase by a specific amount. Two samples were compared, both conditioned on the same increase in their personal income, but on different information about the change in average income.

The results from the analysis indicate that respondents react on the social context given in the valuation scenario, with males having a stronger reaction than females. Respondents who were asked to consider a decrease in their relative income stated a lower increase in WTP (on average) compared to those whose relative income remained unchanged, all else equal. The difference is larger for respondents who reported a positive WTP given the initial scenario. The estimated models included the respondents' WTP (given the initial scenario), as a covariate. The results support the conjecture that this variable captures factors unobservable to the researcher, e.g. attitudes and perceptions about "fair payments". Respondents who stated a high WTP also stated a high increase in their WTP given that their hypothetical income increased. However, when their hypothetical *relative* income decreased, they stated a smaller increase in WTP. I can only speculate why some respondents react stronger than others to the hypothetical income change. However, the results indicate that respondents react to information (change in the average income in Sweden) which according to the conventional CV literature should be irrelevant to them.

Table 8: Spike model on the change of WTP contingent on the hypothetical income change.

Parameter estimates (standard deviations)

	WTP ≥ 0 initial scenario		**WTP > 0 initial scenario**	
Variables	Model 5a ΔWTP	Model 6a ΔWTP	Model 5b ΔWTP	Model 6b ΔWTP
Constant	-0.899 (0.135)***	-2.702 (0.583)**	-0.204 (0.170)	-2.660 (0.797)***
Age		0.009 (0.009)		0.025 (0.012)**
Male		0.399 (0.295)		0.548 (0.371)
Income		0.049 (0.052)		-0.013 (0.062)
"Green"		0.941 (0.302)***		0.635 (0.376)*
WTP		0.002 (0.000)***		0.001 (0.000)***
"Decreased relative income"	-0.605 (0.206)***	0.574 (0.851)	-0.794 (0.252)***	0.750 (1.144)
Rel.Dec·Age		-0.003 (0.014)		-0.007 (0.018)*
Rel.Dec·Male		-0.881 (0.472)*		-1.283 (0.600)**
Rel.Dec·Income		-0.013 (0.077)		0.122 (0.091)
Rel.Dec·Green		-0.736 (0.449)		-0.969 (0.563)*
Rel.Dec·WTP		-0.001 (0.000)**		-0.0015 (0.0006)***
Bid	-0.002 (0.000)***	-0.003 (0.000)***	-0.002 (0.000)***	-0.003 (0.000)***
X^2	1,265***	1,140***	883.26***	1,050***
NOBS	535	508	272	255

*, **, *** indicates if the estimates are significant on the 10, 5 and 1 percent level

Table 9: Mean ΔWTP contingent on the hypothetical income change (Standard deviations)

	ΔWTP unchanged relative income (in SEK)	**ΔWTP decreased relative income (in SEK)**
Whole sample	116 (20)	75 (14)
Part sample (WTP > 0)	233 (42)	114 (23)

Even though an individual's income level is an important determinant of WTP, it is not independent of the social context. In other words, people seem to have perceptions about who should pay for public goods, which implies that an increase in income does not necessarily imply an increase in WTP. This paper asked about WTP for a good that many respondents conceive as a genuine public good: the preservation of biodiversity within a virgin forest that provides value almost exclusively from its nonuse attributes. Many respondents stated that their main motive for valuing the preservation program was their desire to conserve virgin nature for future generations. One interpretation is that peoples' perceived obligation to pay for conserving virgin nature is a function of their *relative* income, such that, when their relative position worsens their sense of obligation weakens. This implies that the income-effect on the WTP for public goods is more complicated than suggested in the conventional CV literature. It also implies that valuation of public goods is not independent of the social context described to respondents in the valuation scenario.

The results may be flawed due to the hypothetical setting used as the foundation of the analysis. Judging from the item non-response, the second valuation question proved to be troublesome. Some respondents seem to have deliberately skipped the question after answering the first valuation question. The amount of text associated with the survey and the hypothetical setting might have discouraged some of these respondents. However, even if the results may be flawed they still indicate that the social context matter to respondents.

In the future, studies examining the income-effect on WTP should more carefully describe their choices of income measure and modelling assumptions and further study the influence of the social context, i.e. in what degree an individual's WTP is influenced by the income levels and contributions of other individuals. Also, studies experimenting with the social context, need to address design issues of CV questions and obtain a better understanding of the workings behind the responses.

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Appendix

Enkätundersökning

- svenska folkets värdering av skogs- och naturskydd

Sasnek-Jullevare väster ut mot Kvikkjokk, Norrbottens län
Foto: Frédéric Forsmark, Länsstyrelsen i Norrbottens län

Hej!

På Umeå universitet bedrivs just nu forskning om människors attityder till natur och miljö.
Du är en av de utvalda som kan hjälpa oss att värdera något som inte har ett uttalat pris, nämligen den svenska urskogen.

Den svenska skogen har under 1900-talet genomgått stora förändringar till följd av det moderna skogsbruket. Skogar där naturen haft sin egen gång utan mänsklig inverkan, så kallade urskogar, har reducerats kraftigt. För att ändra på denna utveckling har Riksdagen beslutat att utvidga skyddet av urskogar och urskogsartade skogar.
Med hjälp av denna enkätundersökning vill vi studera hur mycket urskogen är värd och vilka faktorer som bestämmer detta värde.

Det är betydelsefullt för oss att du svarar på enkäten, oavsett vad du har för inställning till naturreservat och urskog. Enkäten är uppdelad i tre delar och omfattar drygt 25 frågor om din inställning till natur och miljö, ditt förhållande till skogsnatur och om din bakgrund.

Din medverkan är naturligtvis frivillig men dina svar är mycket viktiga och bidrar till att forskningsresultaten blir tillförlitliga. *Dina svar kan inte ersättas med någon annans.*

Varför har just du blivit utvald?
Du är en av de 2000 personer i åldern 18-84 år som blivit slumpmässigt utvald att medverka i undersökningen. Företaget Infodata har gjort urvalet och hämtat adressuppgifter från det statliga personadressregistret (SPAR).
Utskick av enkäten, samt insamling och registrering av svaren sköts av Umeå universitet.

Vad händer med svaren?
Dina svar skyddas enligt 9 kap. 4§ sekretesslagen (1980:100) samt av bestämmelserna i personuppgiftslagen. Detta innebär att alla som jobbar med undersökningen har tystnadsplikt och de insamlade uppgifterna redovisas i tabeller där ingen enskilds svar kan utläsas. Numret på svarskuvärtet är till för att vi under insamlingen ska kunna se vilka som har svarat och vilka som ska få en påminnelse.

Var redovisas resultaten?
Resultaten från undersökningen kommer att redovisas på Umeå universitets hemsida.
Om du har frågor om den praktiska hanteringen av enkäten kan du höra av dig till
Thomas Broberg, Institutionen för nationalekonomi, på telefon 090-786 9565.

TACK FÖR DIN MEDVERKAN!

Med vänliga hälsningar

Runar Brännlund
Professor i nationalekonomi
Umeå universitet

Thomas Broberg
Doktorand i nationalekonomi
Umeå universitet

DEL 1

Inledningsvis vill vi ställa några frågor om ditt förhållande till natur och miljö.

1.1 Har du under det senaste året arbetat med något av följande?

- □ Skogsbruk eller timmerproduktion
- □ Träförädling
- □ Miljöskydd
- □ Rennäring
- □ Naturturism
- □ Inget av ovanstående

1.2 Är du medlem i någon miljöförening/organisation?

- □ JA
- □ NEJ

1.3 I regeringens förslag till årets statsbudget summeras statens samtliga utgifter till 738 miljarder kronor. En av statens utgiftsposter är ”*allmän miljö- och naturvård*”, vilken utgör 0,5 % (4 miljarder kronor) av statens totala utgifter. Utslaget över antalet skattebetalare innebär detta en genomsnittlig skatteinbetalning på ungefär 600 kronor om året. Vad anser du om denna tilldelning? (se gärna faktarutan nedan för mer information)

□ För hög □ Lagom □ För låg □ Vet ej

Exempel på andra statliga utgiftsposter och deras procentuella andel av statens totala utgifter. Inom parantes anges hur stor genomsnittlig inbetalning per skattebetalare och år varje utgiftspost kräver.

Försvar samt beredskap mot sårbarhet	6 %	(7500 kronor)
Hälsovård, sjukvård, och social omsorg	5,4 %	(6500 kronor)
Ekonomisk trygghet för familjer och barn	7,6 %	(9000 kronor)
Utbildning och universitetsforskning	5,9 %	(7500 kronor)
Ekonomisk trygghet vid sjukdom och handikapp	17,6 %	(21000 kronor)
Regional utveckling	0,5 %	(600 kronor)
Arbetsmarknad	9,4 %	(11 000 kronor)
Kommunikationer (transport, IT, post)	4,3 %	(5000 kronor)
Kultur, medier, trossamfund och fritid	1,2 %	(1500 kronor)

1.4 Äger du, eller någon annan i ditt hushåll, skog?

- ☐ JA, mer än 20 hektar
- ☐ JA, 20 hektar eller mindre
- ☐ NEJ

1.5 Hur många gånger under det senaste året har du vistats i skogsnatur med följande huvudsyfte? (Kryssa i ett alternativ per aktivitet).

	Aldrig	1 till 5 gånger	6 till 10 gånger	11-50 gånger	Mer än 50 gånger
Plocka bär och svamp	☐	☐	☐	☐	☐
Utflykt (picknick, vandring, etc.)	☐	☐	☐	☐	☐
Sporta (löpträna, cykla, orientera, skidlöpa etc.)	☐	☐	☐	☐	☐
Fiska	☐	☐	☐	☐	☐
Arbeta	☐	☐	☐	☐	☐
Jaga	☐	☐	☐	☐	☐
Annat (ange vilket nedan)	☐	☐	☐	☐	☐

_____

Om du aldrig vistats i skogen under det senaste året kan du gå vidare till DEL 2 på sida 6.

1.6 Ungefär hur många kilometer färdas du i genomsnitt, enkel väg, för att utföra de aktiviteter i skog och natur som du angav i föregående fråga? (Kryssa i ett av alternativen nedan.)

- ☐ 0 km -1 km
- ☐ 1 km - 2 km
- ☐ 2 km - 3.5 km
- ☐ 3,5 km -5 km
- ☐ 5 km - 7,5 km
- ☐ 7.5 km - 10 km
- ☐ 10 km -30 km
- ☐ 30 km -

Var finns det urskog och urskogsartad skog?

Den största delen av urskogar och urskogsartade skogar ägs av staten och cirka 80% finns nära fjällvärlden. Det fjällnära regionen motsvaras av det skuggade området i figuren till vänster, och i den ingår delar av *Norrbottens län* (Kiruna, Pajala, Gällivare, Jokkmokk, Arvidsjaur och Arjeplog kommun), *Västerbottens län* (Sorsele, Storuman, Dorotea och Vilhelmina kommun), *Jämtlands Län* (Härjedalen, Strömsund, Krokom, Åre och Berg kommun) och den norra delen av *Dalarnas Län* (Älvdalens kommun).

1.7 Ligger din bostadsort 10 mil eller närmare den fjällnära regionen? (se karta och text ovan)

JA ☐
NEJ ☐
VET EJ ☐

1.8 Har du någon gång under det senaste året besökt skogsområden inom, eller i närheten av, den fjällnära regionen?

JA ☐
NEJ ☐→ **Gå vidare till DEL 2. Nästa sida.**
VET EJ ☐

1.9 Vilka av följande aktiviteter har du utfört i skogsområden inom, eller i närheten av, den fjällnära regionen?

Plockat bär och svamp	☐	Sportat (löpträna, cykla, orientera, skidlöpa etc.)	☐
Utflykt (picknick, vandrat, etc.)	☐	Fiskat	☐
Arbetat	☐	Jagat	☐
Annat (ange vilket nedan)	☐		

_____

DEL 2

VIKTIGT ATT LÄSA INNAN DU BESVARAR FRÅGA 2.1

Fakta om dagens och framtidens skydd av fjällnära urskog

Idag skyddas 660 000 hektar (1 hektar = 10 000 kvadratmeter) av totalt 1 534 884 hektar avverkningsbar skogsmark i den fjällnära regionen, det vill säga 43 % av skogsmarken är skyddad. Enligt Naturvårdsverket finns det ytterligare 126 000 hektar skyddsvärd skog i regionen. De föreslagna skogsområdena är ofta närliggande till redan skyddade områden. Om man även skulle skydda denna skog innebär det att totalt 51% av skogen i regionen skyddas. Längst bak i enkäten finns en lista på de största skogarna i regionen, som av Naturvårdsverket ansetts skyddsvärda och en karta på var dessa skogar är belägna.

Vad avgör om projektet är värt att genomföra?

För att veta om Naturvårdsverkets förslag är värt att genomföra måste både nyttan och kostnaden av det uppskattas. Nyttan av projektet är till stora delar beroende på det svenska folkets värdering av de fjällnära urskogarna i dess oavverkade tillstånd.

Argument för att skydda ytterligare hektar av statlig fjällnära urskog

- **Västeuropas största tillgång av naturliga skogsekosystem*:*** Områdena karaktäriseras som vidsträckta obrutna skogsområden.
- **Skydd av biologisk mångfald:** Biologisk mångfald är bland annat viktigt för ett fungerande ekosystem, men också för framtagandet av nya vacciner och mediciner.
  Det moderna skogsbruket har förvandlat det svenska skogslandskapet, och av allt att döma finns det ett stort antal skogslevande arter som förväntas dö ut till följd av detta. I de svenska skogarna finns cirka 350 arter (svampar, mossor, däggdjur, skalbaggar, fjärilar, blommor mm.) vars existens är akut eller starkt hotad. Urskogar, där naturen får ha sin egen gång är speciellt viktiga för många av dessa arter.
- **Områdena är viktiga för rennäringen**.
- **Områdena är viktiga för friluftsliv och naturturism:** Områdena har unika estetiska egenskaper (kombination av obruten skog, orörda fjäll, myrar, sjöar).

Argument mot att skydda ytterligare hektar av statlig fjällnära urskog

- **Uteblivna statliga intäkter**: Att skydda fjällnära urskog genom att upprätta naturreservat medför även *kostnader* eftersom staten går miste om intäkter som den skulle ha haft om skog avverkats och sålts.
- **Högre produktionskostnader:** Att skydda skog kan också leda till ökade kostnader för träförädlingsindustrin, inom och angränsande till den fjällnära regionen, som då i större utsträckning måste köpa virke från andra områden längre bort.
- **Högre samhällsekonomiska kostnader:** Ökade kostnader för företagen kan få som konsekvens att arbetstillfällen flyttas eller helt försvinner från berörda orter, vilket också ger upphov till kostnader för staten, men också för berörda individer och kommuner.

Nu följer några frågor om din inställning till skydd av urskog och hur du värderar detta skydd. Utgångspunkten för frågorna är Naturvårdsverkets förslag om att öka den skyddade skogen från 43% till 51% i den fjällnära regionen, det vill säga avstå från att avverka skog som staten äger och som anses avverkningsbar.

2.1 *Tänk dig in i den beskrivna situationen och besvara därefter frågan som om det vore ett val i verkliga livet. Det är viktigt att du har i tanken att du har begränsade ekonomiska resurser (din inkomst efter skatt), och att det är du som bestämmer hur de ska fördelas på olika saker.*

1) Är du villig att betala för att öka den skyddade skogen från 43% till 51% i den fjällnära regionen enligt Naturvårdsverkets förslag. Betalningen sker i form av en ökning av dina skatteutgifter under de nästkommande fem åren.

JA □→ **Gå vidare till fråga 2.1.2.**

NEJ □→ **Gå vidare till fråga 2.3. Nästa sida.**

2) Hur mycket skulle du maximalt vara villig att betala per år för att öka den skyddade skogen från 43% till 51% i den fjällnära regionen? Det belopp du anger måste betalas i form av ökade skatteutgifter varje år de nästkommande fem åren och gäller bara för dig.

□ 10	□ 20	□ 40	□ 70	□ 600	□ 800	□ 1100	□ 1500
□ 120	□ 200	□ 300	□ 420	□ 2000	□ 2700	□ 3500	□ 5000-

← Belopp i kronor per år.

2.2 Nu vill vi veta varför du är villig att betala för att skydda fjällnära urskog. Här nedan följer fem påståenden som vi vill att du ska rangordna från 1-5. Sätt 1 för det påstående som stämmer bäst överens med dig och 5 för det som stämmer sämst överens med dig. Om något påstående inte alls stämmer överens med dig lämnar du rutan för det alternativet blankt och rangordnar endast de övriga alternativen.
Att bevara urskog och urskogsartad skog i den fjällnära regionen är viktigt för mig därför att:

□ Jag vill bevara urskog till kommande generationer

□ Naturen har ett egenvärde och jag vill att det ska finnas betydande områden där naturen får ha sin gång.

□ Jag planerar att besöka skogsområde inom regionen.

□ Jag planerar inte att besöka skogsområde i regionen just nu, men vill bevara möjligheten att göra det någon gång i framtiden.

□ Jag vet att området är viktigt för andra människor och jag vill därför skydda det.

Gå vidare till fråga 2.4. Nästa sida.

2.3 Ange orsaken till att du inte är villig att betala för att öka skyddet av statligt ägd produktiv urskog i den fjällnära regionen från 43% till 51%. (kryssa i ett alternativ nedan).

- □ Jag tycker att tillräckligt mycket urskog redan är skyddad i den angivna regionen.
- □ Jag bryr mig inte om skyddet av urskog i just den angivna regionen och vill därför inte betala. Jag skulle hellre vilja skydda skog i någon annan region.
- □ Jag vill att urskog ska skyddas, men det är inte en prioriterad utgift för mig.
- □ Jag bryr mig inte överhuvudtaget om skyddet av urskog och vill därför inte betala.

Om du vill att urskogen ska skyddas men att det inte är en prioriterad utgift för dig gå vidare till fråga 2.4. Gå annars vidare till DEL 3.

2.4 Föreställ dig en situation där den genomsnittliga inkomstnivån i samhället ökat med 2000 kronor i månaden efter skatt (24 000 kronor högre per år), samtidigt som den allmänna prisnivån inte förändrats. Föreställ dig även att din inkomst efter skatt har ökat med 1000 kronor i månaden (12 000 kronor högre per år), vilket betyder att din inkomstutveckling har varit sämre än den genomsnittliga.

1) Skulle du i denna situation vara villig att betala för att öka den skyddade skogen från 43% till 51% i den fjällnära regionen enligt Naturvårdsverkets förslag. Betalningen sker i form av ökade skatteutgifter under de nästkommande fem åren.

JA □→ **Gå vidare till fråga 2.4.2.**

NEJ □→ **Gå vidare till DEL 3. Nästa sida.**

2) Hur skulle du i denna situation förändra din betalningsvilja som du angav i fråga 2.1.2? (*om du i fråga 2.1 svarade att du inte var villig att betala, men i fråga 2.4.1 svarat att du är villig att betala, kryssa i höja*)

□ Höja □ Sänka □ Inte ändra → **Gå vidare till DEL 3. Nästa sida.**

3) Hur mycket skulle du höja eller sänka det maximala belopp per år du var villig att betala i fråga 2.1 om din och den genomsnittliga inkomsten förändrades som ovan angivits. Det belopp du anger måste betalas i form av ökade skatteutgifter varje år de nästkommande fem åren och gäller bara för dig. (kryssa i ett av alternativen nedan)

□ 10	□ 25	□ 50	□ 80		□ 420	□ 520	□ 630	□ 750	← **Förändring av belopp i kronor per år.**
□ 120	□ 170	□ 250	□ 330		□ 1000	□ 1250	□ 1500	□ 2500-	

DEL 3

Avslutningsvis vill vi ställa några frågor om din bakgrund.

3.1 Födelseår?_____

3.2 Är du

- ☐ Man
- ☐ Kvinna

3.3 Levnadsförhållande

- ☐ En person i hushållet
- ☐ Bor i hushåll utan barn
- ☐ Bor i hushåll med barn

3.4 Hur många barn har du?

- ☐ Inget barn
- ☐ 1 barn
- ☐ 2 barn
- ☐ 3 barn
- ☐ Fler än tre barn

3.5 Betraktar du din bostadsort mest som:

- ☐ Stad (10 000 eller fler invånare)
- ☐ Förort
- ☐ Kommunal centralort på landsbygd (4000-10000 invånare)
- ☐ Större by i landsbygd (2000 – 4000 invånare)
- ☐ Glesbygd
- ☐ Vet inte

3.6 Har du någon gång under ditt liv varit bosatt 10 mil eller närmare den fjällnära regionen under en längre period än tre år? (se karta och faktaruta på sida 5 om du är osäker).

- ☐ JA
- ☐ NEJ

3.7 Vilken är din högsta avslutade utbildningsnivå?

- □ Universitet eller högskola mer än tre år
- □ Universitet eller högskola tre år eller mindre
- □ Folkhögskola
- □ Gymnasiet (2-årig eller 3-årig)/Yrkesskola
- □ Grundskola /Folkskola/Realskola
- □ Inget av de föregående

3.8 Vilken är din totala månadsinkomst före skatt? (Med inkomst menar vi arbetsinkomst, arbetslöshetsunderstöd och sjukersättning samt pension. Däremot ska du inte ta med barn- och bostadsbidrag samt förmåner och traktamenten)

□ 0 – 6 999	□ 28 000 – 30 999
□ 7 000 – 9 999	□ 31 000 – 33 999
□ 10 000 – 12 999	□ 34 000 – 36 999
□ 13 000 – 15 999	□ 37 000 – 39 999
□ 16 000 – 18 999	□ 40 000 – 42 999
□ 19 000 – 21 999	□ 43 000 – 45 999
□ 22 000 – 24 999	□ 46 000 – 48 999
□ 25 000 – 27 999	□ 49 000 –

3.9 Vilket av följande alternativ beskriver bäst vad din inkomst utgörs av?

- □ Arbetslöshetsunderstöd
- □ Pension
- □ Pension och arbetsinkomst
- □ Sjukersättning och arbetsinkomst
- □ Arbetsinkomst
- □ Inget av ovanstående

Hur många timmar i veckan arbetar du i genomsnitt? ____timmar

3.10 Vilken är ditt hushålls totala månadsinkomst före skatt?

□ 0 – 9 999	□ 45 000 – 49 999
□ 10 000 – 14 999	□ 50 000 – 54 999
□ 15 000 – 19 999	□ 55 000 – 59 999
□ 20 000 – 24 999	□ 60 000 – 64 999
□ 25 000 – 29 999	□ 65 000 – 69 999
□ 30 000 – 34 999	□ 70 000 – 74 999
□ 35 000 – 39 999	□ 75 000 – 79 000
□ 40 000 – 44 999	□ 80 000 –

3.11 Det finns ett antal faktorer som påverkar oss när vi väljer vilka varor vi ska köpa, bland annat våra grundläggande behov, intressen och konsumtionsvanor. Forskning har visat att våra konsumtionsbeslut även påverkas av vad andra människor konsumerar, det vill säga, vi jämför oss med andra människor genom att influeras av reklam eller av direkta iakttagelser av vad andra människor äger.
I vilken utsträckning påverkas dina konsumtionsbeslut av följande?

	Ingen påverkan	Svag påverkan	Stark påverkan
Den allmänna konsumtionstrenden hos dina grannar.	□	□	□
Den allmänna konsumtionstrenden i den kommun eller den ort där du bor.	□	□	□
Den allmänna konsumtionstrenden bland människor som är av samma kön och ålder som dig.	□	□	□
Den allmänna konsumtionstrenden i föreningar/organisationer där du är medlem.	□	□	□
Den allmänna konsumtionstrenden hos dem du tror har samma ekonomiska standard/inkomstläge som dig.	□	□	□
Den allmänna konsumtionstrenden bland dem, som du anser vara mer förmögna än dig.	□	□	□
Den allmänna konsumtionstrenden bland släkt och nära vänner.	□	□	□
Den allmänna konsumtionstrenden i Sverige	□	□	□

I tabellen nedan finns ett urval av skogarna i den fjällnära regionen som av Naturvårdsverket anses skyddsvärda. Notera att endast de största områdena anges i tabellen på grund av utrymmesskäl. Områdenas storlek anges både i termer av total areal, vilket motsvarar allt land och vatten i ett specifikt område, och produktiv skogsmark, som endast består av marken där skogen står.

Nummer	Namn	Kommun	Total areal (land och vatten) i hektar	Areal produktiv skogsmark i hektar
1	Björnliden	Arjeplog	1 653	1 337
2	Övre Piteälven	Arjeplog	8 177	2 798
3	Tjipkojaure	Arjeplog	3 489	1 750
4	Iksjak	Arjeplog	9 833	4 368
5	Guongek	Arjeplog	6 838	5 168
6	Kaddåive	Arjeplog	1 832	1 417
7	Bällovaratj	Arvidsjaur	3 082	2 352
8	Stridsberg	Dorotea	1 732	1 372
9	Karhuvaara	Gällivare	17 901	9 221
10	Ätnaråvve	Gällivare	2 532	1 997
11	Linavare-Råneträsket	Gällivare	7 637	2 931
12	Övre Ránddalen	Härjedalen	4 373	1 684
13	Storhärden	Härjedalen, Älvdalen	2 654	1 203
14	Jelka-Rimakåbbå	Jokkmokk	36 955	24 771
15	Sasnek-Jullevare	Jokkmokk	6 184	3 429
16	Lulep Låmenåive	Jokkmokk	4 674	2 399
17	Tjaraivare	Jokkmokk	2 160	1 334
18	Kuoratjåive	Jokkmokk	5 002	3 190
19	Vuojat-Naustasjåkkå	Jokkmokk	6 478	3 957
20	Rakalvis	Jokkmokk	6 327	3 552
21	Låkkejaure-Sörberget	Jokkmokk	11 308	7 656
22	Lattakasse	Jokkmokk	3 626	2 201
23	Njannja	Jokkmokk	11 464	6 110
24	Ranesvare	Jokkmokk, Gällivare	7 583	3 220
25	Ananasse	Jokkmokk, Gällivare	10 993	6 485
26	Luongastunturi	Kiruna	13 542	9 262
27	Vittaselkä-Muosselkä*	Pajala	2 677	1 925
28	Vittalaki-Aljunjoki*	Pajala, Kiruna	3 689	2 307
29	Smilaliden	Sorsele	1 895	1 480
30	Raningsberget	Sorsele	1 360	1 131
31	Matsorliden	Sorsele	2 128	1 545
32	Brattiken	Storuman	1 719	1 028
33	Akkan	Storuman	2 085	1 162
34	Arvliden	Storuman, Sorsele	2 715	2 077
35	Härbergsdalen- Rörâhöjden	Strömsund	30 993	13 093
36	Skorne	Vilhelmina	2 037	1 685
37	Östra Svartsjöliden	Vilhelmina	2 046	1 841
38	Storvarden	Älvdalen	5 866	3 268
Totalt			257 209	122 935

För ytterligare information se kartor på enkätens sista sida där de angivna skogarnas läge lokaliseras med hjälp av deras respektive nummer i tabellen ovan. Skogarna markerade med * finns inte utsatta på kartorna.

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